THE

AMERICAN NATURALIST

VOL. XXXIII. *May, 1899.* No. 389.

STUDIES ON REACTIONS TO STIMULI IN UNICELLULAR ORGANISMS.

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III. REACTIONS TO LOCALIZED STIMULI IN SPIROSTOMUM AND STENTOR.

IN the second of these studies (*American Journal of Physiology*, May, 1899) the writer has given an account of the mechanism of the reactions of Paramecium that involves an entirely different conception of the nature of these activities from that which has been generally assumed. It was shown that this protozoan has but one motor reaction in response to the most varied stimuli, and that it reacts without any relation whatever to the position of the stimulating agent, so that it cannot be said to be attracted or repelled by any agency or condition — its reaction being strictly comparable in all essentials to that of an isolated muscle. The importance of this, in case it should turn out to be the general method of reaction for unicellular organisms, is obvious, involving, as it does, the rejection of almost all hitherto received theories of the mechanism of reactions; the question, therefore, immediately arose as to whether this method of reaction was to be extended to other Protozoa. The following study of the reactions of Spirosto-

mum and Stentor is presented as a contribution toward answering this question.

The minute size of Paramecium brought with it the great disadvantage that it was not possible under experimental conditions to apply localized stimuli to definite parts of the body, so that recourse was necessary to observation of chance contacts of sources of stimuli with one or another part of the body; an unsatisfactory method, and one requiring much time and patience. This difficulty is obviated in *Spirostomum ambiguum* and *Stentor polymorphus*, which are both so large that there is no difficulty in applying stimuli to any desired region on the surface of the body. The simplest means of doing this is to touch any point on the surface of the body with a proper instrument, thus giving the animal a sharply localized mechanical stimulus. Other methods are given in the following account of observations.

Spirostomum ambiguum (Fig. 1).

Spirostomum ambiguum is one of the largest of unicellular animals, reaching a length of two or three millimeters. The average length of those on which the following observations were made was about one and one-half millimeters. In form Spirostomum is a long, slender cylinder of nearly equal diameter throughout, but slightly smaller at the ends. The mouth lies behind the middle of the body, and from this a band of large cilia (the adoral zone) runs to the anterior end of the body. The large contractile vacuole lies at the posterior end, and from this a canal runs almost the entire length of the body near its aboral side, or curving a little onto the right side. The adoral zone and this canal form important landmarks for determining directive relations in studying the movements of the animals. The posterior end is truncate, while the anterior end is rounded and shows a difference in its contour on the two sides of the animal. The tip is curved slightly toward the side on which the mouth is situated (the oral side), so that on the opposite or aboral side the contour is a long convex curve, while on the oral side there is almost an angle. These facts are best

appreciated in the figure; while not prominent, they are visible, and are of the greatest importance for orientation while studying the movements of the animal. The difference in the two contours of the anterior end possibly does not correspond precisely to the distinction between the oral and aboral sides, as determined by the position of the mouth; the exact relation of parts is very difficult to determine on account of the continual twisting movements of the animal. But the difference in contours in any case marks very nearly the oral and aboral sides, so that when the aboral side is spoken of in the following account it signifies that side of the anterior end in which the curve is longest, while the oral side is that which presents the shortest curve (see Fig. 1). The entire surface of the animal is covered with cilia, arranged in somewhat oblique longitudinal rows.

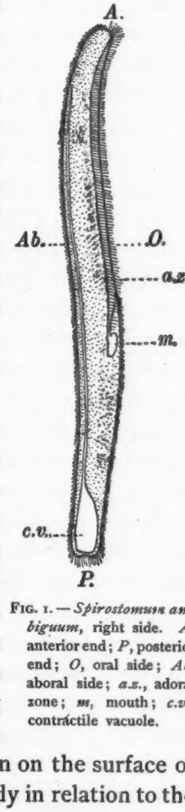

Fig. 1. — *Spirostomum ambiguum*, right side. *A*, anterior end; *P*, posterior end; *O*, oral side; *Ab*, aboral side; *a.z.*, adoral zone; *m*, mouth; *c.v.*, contractile vacuole.

The unstimulated Spirostomum swims forward by means of the backward stroke of its cilia; at the same time it may revolve on its long axis. This revolution is usually from right to left. The body (as shown in Fig. 1) is not quite straight, but a little in front of the middle is slightly bent, so that the anterior part, as the body revolves, describes the surface of a cone. Owing to the animal's continual movement and its power of twisting into a spiral and of bending sharply, taken in connection with the only slight differentiation on the surface of the cylindrical body, the orientation of the body in relation to the direction of movement is very difficult to determine. But by keeping the attention fixed upon the form of the anterior end, as described above, it is possible under favorable conditions to observe that the aboral side of the anterior end is always on the outside of the cone, the oral side looking within. As the animal moves forward in connection with this revolving motion,

the path of course becomes a spiral; it agrees exactly with the path of Paramecium, in that the aboral side always looks toward the outer side of the spiral. At times the animal swims some distance without revolving on its long axis; at such times the path is not a spiral.

We will now proceed to a systematic examination of the changes in motion due to stimuli of different sorts and applied at different points on the animal's body.

A. *Mechanical Stimuli.*

The method of study consisted in touching with a capillary glass rod, of less diameter than the animal's body, different points on the surface of the animal, and noting the reactions caused. This procedure presents no difficulties.

1. *Stimulus at Anterior End.* — If the animal is touched at the anterior end with the tip of the glass rod, it immediately contracts strongly, becoming short and thick, and the zones of cilia forming spirals surrounding the body, in the manner well known. (See the figure given by Bütschli in *The Protozoa of Bronn's Klassen und Ordnungen des Thierreichs*, Taf. LXVII, Fig. 2 *b*.) At the moment of contraction it darts backward a little. It then gradually extends, continuing to swim backward. As it swims backward it revolves on its long axis, in all cases observed, from right to left, in the same direction as when swimming forward. Next it begins to turn its anterior half to one side, usually at the same time beginning to swim forward. Like Paramecium, it always turns toward the aboral side of the anterior end. It usually revolves at the same time, so as to describe a very wide spiral, with the aboral side on the outside of the spiral, finally straightening out and swimming forward in the direction indicated by the position of the aboral side at the time it straightens. Briefly, the animal when stimulated at the anterior end contracts, backs off, turns to the aboral side, and swims forward on a path which lies at an angle to the path on which it was previously swimming. In the case of a very slight stimulus the contraction may be omitted, the rest of the reaction being given as usual, ex-

cept that the animal swims only a short distance backward before turning.

2. *Stimulus at Posterior End.* — If now the animal is touched at the posterior end, exactly the same reaction is produced. It contracts, then swims backward, — therefore toward the point of stimulus (whereas in the other case it swam away from the point of stimulus). Then it curves toward the aboral side, describing a wide spiral, and finally swims forward in the direction of the aboral side, exactly as described above. It makes no difference to the reaction which way the animal is swimming when stimulated: if swimming forward, the direction is changed; if swimming backward when touched at the posterior end, it continues to swim backward after contracting.

The posterior end is slightly less sensitive than the anterior, so that a very weak stimulus at the posterior end may cause no reaction at all. No matter where stimulated there are rare cases in which the animal when stimulated merely contracts (always darting back a little at the moment of contraction), then stops for a time, then resumes a forward motion. Out of one hundred cases stimulated at the anterior end, ninety-six reacted in the typical manner, while four gave the incomplete reaction just mentioned. Out of one hundred cases stimulated at the posterior end, ninety-two gave the typical reaction, while eight reacted incompletely. This difference in the number giving the typical reaction is probably a mere statistical variation, which would disappear with larger numbers; if any significance is to be attached to it, it is merely that already noted — that the posterior end is slightly less sensitive than the anterior.

The reaction is thus exactly the same whether the stimulus occurs at the anterior or the posterior end.

3. *Stimulus at One Side.* — When the animal is touched anywhere on the surface of the body between the two ends, the same reaction is given as in the two foregoing cases; the animal contracts, swims backward, curves toward the aboral side, and swims forward toward that side. The final direction in which it swims bears no relation to the position of the side on which the stimulus was given.

4. *Stimulus Unlocalized.* — An unlocalized mechanical stimu-

lus can be given by jarring the dish or slide containing the animals. They contract, swim backward, turn toward the aboral side, and swim forward, exactly as in the other cases.

Thus the reaction given by Spirostomum to a mechanical stimulus is identically the same, whatever part of the body is stimulated, or even if the stimulus is not localized at all. A diagram of the reaction of Spirostomum to a stimulus is given in Fig. 2.

5. *Repeated Stimuli.* — When the same animal is repeatedly stimulated, certain features in the reaction are especially worthy of notice. At the first stimulus the animal contracts, then

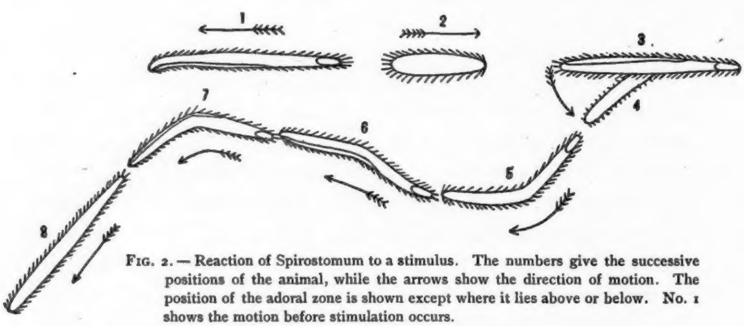

FIG. 2. — Reaction of Spirostomum to a stimulus. The numbers give the successive positions of the animal, while the arrows show the direction of motion. The position of the adoral zone is shown except where it lies above or below. No. 1 shows the motion before stimulation occurs.

swims backward. Now if, after recovering from the contraction, but while still swimming backward, it is again stimulated, it again contracts and continues to swim backward. On a third stimulation, while still swimming backward, it usually *reverses* its course and swims forward. A reversal of the direction of motion now usually occurs at each new stimulus up to four or five. This reversal at each new stimulus may easily give the impression that the animal is swimming each time away from the source of stimulation, and hence that it is reacting with relation to the localization of the stimulus; but this appearance is due merely to a psychological peculiarity of the experimenter. It is natural for the experimenter to touch the animal at the end toward which it is moving — to "head it off" as it were. On the third trial he will, as above stated, usually succeed in getting it to reverse its motion and swim in the opposite direc-

tion. He then "heads it off" again by touching the other end toward which it is now swimming, with the result that it reverses again. This alternation on the part of experimenter and infusorian may continue for a number of times, giving the impression that the animal is clearly reacting with reference to the position of the source of stimulus, fleeing from it in each case. But this alternation is really an independent phenomenon in each of the two organisms concerned in the experiment, as is proved by the following. If the experimenter continues to stimulate the animal at the same end, regardless of the direction in which it is moving, the animal's direction of motion will alternate as before. Thus, after the second stimulation, while the Spirostomum is swimming backward, if stimulated at the anterior end, it will now swim forward or toward the source of stimulus; if stimulated again at the anterior end, it will reverse and swim backward; again, and it swims forward once more. In these cases, as in the others, therefore, the direction of motion has no relation to the localization of the stimulus.

If the stimulations are continued after five or six times, the animal will continue to swim violently in one direction or the other, without regard to the repetition of the stimulus or its localization. It is thus possible to stimulate the animal repeatedly at its posterior end while it is swimming violently to the rear, and thus toward the source of stimulus; in other cases it swims as violently away from the stimulus. In no case does the position of the stimulus have any effect on the direction of motion.

B. *Chemical Stimuli.*

It is easy to localize the action of chemical stimuli in the following manner. A capillary glass rod is coated with paraffin. A crystal of NaCl or other salt is then attached to the rod by means of the paraffin coating, and can then be held near to any part of the animal's body.

1. *Stimulus at Anterior End.* — The crystal of NaCl is held close to the anterior end of the Spirostomum, but without touching it, so that only the diffusing salt in solution comes in contact with the animal. The Spirostomum contracts, swims

backward (away from the source of stimulus), turns toward the aboral side, and swims forward, exactly as in the case of a mechanical stimulus.

2. *Stimulus at Posterior End.* — The crystal of salt is held close to the posterior end. The animal contracts and swims backward — therefore *toward* the source of stimulus. It thus either strikes the crystal of NaCl or passes through the densest part of the solution; then continues backward some distance, finally turning toward the aboral side and swimming forward.

3. *Stimulus at the Side.* — The animal reacts as in the two preceding cases, the direction of motion having no relation to the position of the stimulus.

4. *Stimulus Unlocalized.* — The Spirostoma are dropped directly into 2 per cent NaCl. They contract, swim backward, turn about irregularly, and soon die.

The following experiment, giving results in almost all the above categories, is particularly striking. A number of Spirostoma are placed on a slide in a considerable quantity of water. Then a few crystals of NaCl are placed in the center, the cover-glass quickly supplied, and the reactions of the animals noted. All those in the immediate neighborhood of the NaCl soon contract and swim backward, as the flood of salt solution diffusing from the crystals comes against them. The Spirostoma are scattered, with axes oriented in no special direction, therefore some lie with anterior ends directed toward the mass of salt, so that this end first comes in contact with the salt solution; others with posterior end thus directed; others with long axis oblique to the direction of the mass of salt. All contract and swim backward, whatever part of the body is first met by the diffusing solution of NaCl. Those with anterior ends directed toward the mass, swimming backward, of course move directly away from the salt. Those with posterior end toward the salt, likewise swimming backward, pass directly into the densest part of the solution of NaCl, and are quickly plasmolyzed and killed. Those with long axis oblique to the direction of the NaCl also swim backward, some thus approaching more or less obliquely the solution of NaCl; these do not turn,

but swim straight on, crossing the area and coming out on the other side, unless plasmolyzed and killed during the passage.

It is evident that the Spirostoma are neither attracted nor repelled by the NaCl; it merely sets in operation their one reaction, and this takes them into danger or safety as chance may direct. Under normal conditions, of course, the anterior end will usually be directed toward the stimulating agent, since the animal generally swims forward, and masses of dangerous chemicals are not often dropped suddenly into the midst of a group of the Infusoria; hence the device of swimming backward usually saves the animal. The following curious experiment shows how possibly a combination of circumstances might arise even under normal conditions such that the reaction would result in the destruction of the animal. A small mass of NaCl was slowly dissolving in the center of the slide. A Spirostomum was swimming forward directly away from the diffusing salt, not being in the region of its influence at all. Its posterior end was thus pointed toward the salt, but as it was swimming away it was in no danger. Now a slight jar was given to the preparation — such as might easily occur in nature. Thereupon the Spirostomum reacted in the usual manner, by contracting and swimming backward. It thus swam toward the NaCl, until finally its posterior end came in contact with the advancing flood of salt solution. Thereupon the customary reaction was again induced still more powerfully; the animal contracted and swam still more swiftly backward; thus entering the salt solution, it was plasmolyzed and killed.

When a Spirostomum swimming forward comes in contact with a diffusing chemical, it contracts, darts backward, then swings its anterior end about, finally turning toward the aboral side and swimming straight forward — so long as this does not take it again into the region of the stimulating agent. If it does, the reaction is repeated until by the laws of chance the Spirostomum is directed into a region which does not cause stimulation. If the stimulus with which the anterior end comes in contact is very weak, the animal may omit the contraction and move a little backward without contracting; then the anterior end is swung about in a circle (the aboral side, of course,

toward the outside of the circle), while the animal starts forward. So long as the anterior end is thus carried into a medium which causes the weak stimulus, the forward movement is at once checked and the animal jerks backward again; as soon, however, as the anterior end in its circling comes into a direction such that swimming forward does not carry the animal into a region causing the reaction, the animal continues to swim straight forward. All these facts find a precise parallel in the reactions of Paramecium.

When the Spirostomum is swimming backward, the course is never changed by the circling about of the posterior end and the turning in one way or another, as it is when the anterior end is directed forward; the posterior end seems to have no power of initiating a turning movement. In this connection the reactions of the separate parts of a Spirostomum, cut into two or more pieces, is of interest.

C. *Reactions of Separated Parts.*

There is no difficulty in cutting Spirostomum with scissors or scalpel transversely into short pieces. Any piece with which the anterior end remains in connection, though it be but one-tenth of the entire animal, reacts in essentially the same way as the entire organism — by contracting, swimming backward, turning and swimming forward. Its motion, perhaps, differs a little in degree from that of the entire animal in the fact that turning is more frequent and pronounced, the piece at times swimming in a small circle. The direction of turning is, as in the uninjured specimen, toward the aboral side. Any piece from which the anterior end is separated, while the posterior end is uninjured, reacts as follows. When stimulated, it contracts and swims backward, *does not turn*, but soon swims forward. It swims but a short distance forward, then starts backward again; after going in this direction once or twice its own length, it swims forward about the same distance; then again backward. It continues thus to oscillate back and forth indefinitely. When the anterior end is removed, therefore, the motion takes the form of a rhythmical back and forth move-

ment. This is true when the posterior piece comprises as much as nine-tenths of the entire animal.

It seems, therefore, that the power of initiating a turn, and the power of continuing a course once begun, are localized in some way in the anterior end.

Stentor polymorphus (Fig. 3).

Stentor polymorphus is smaller than *Spirostomum ambiguum*, but is still of sufficient size to make the application of localized stimuli a matter of no difficulty. It is a trumpet-shaped animal, exceedingly changeable in exact form and proportions. Fig. 3 shows a usual form of the animal when swimming freely; when anchored by its base the form is more extended and slender. The surface of the animal is covered with cilia in longitudinal rows, while the broad anterior end, known as the peristome, is surrounded by a circle of larger cilia forming the adoral zone. At one side of the disk is a funnel-like depression which leads into the mouth. That surface of the body nearest to which the mouth lies may be called the oral surface; the opposite one, the aboral surface. Considering the oral as equivalent to ventral surface, we may define right and left sides as follows: When the oral surface is below, and the anterior end is away from the observer, the right and left sides of the animal correspond to the observer's right and

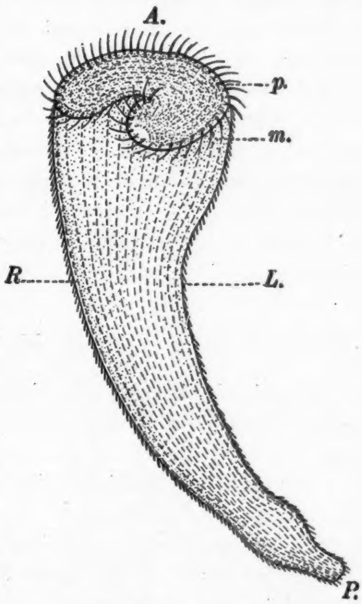

Fig. 3. — *Stentor polymorphus*, partially contracted free-swimming individual, oral surface. *A*, anterior end; *P*, posterior end; *L*, left side; *R*, right side; *m*, mouth; *p*, peristome.

left. (In the figure the oral surface is above, so that right and left sides are reversed.) The body of the animal is usually curved, being bent from the direction of the anterior end toward the left side; sometimes there is near the posterior end a second short curve to the right.

Stentor polymorphus is often found attached by its posterior end; at other times it swims freely in the water. The motion in the free-swimming individuals is as follows: The animals swim slowly forward; at the same time they may or may not revolve on the long axis. The revolution when it occurs is usually, if not invariably, to the left. When the animal swims forward without revolving on its long axis, the path is usually a curved one, the animal continually swerving toward its right side. In this way the Stentors usually describe circles of greater or less radius. If they revolve as they swim forward, they continually swerve to the right also; but owing to the revolution, the right side continually changes its position, so that the path becomes a spiral one, as in Paramecium and Spirostomum. The motion of *Stentor polymorphus* is usually very slow, so that all these relations are observable without the slightest difficulty.

A. *Reactions to Mechanical Stimuli.*

The animals were stimulated in the same way as Spirostomum, by touching them at any desired point with a capillary glass rod.

1. *Stimulus at Anterior End, on Peristome.*—The animal contracts and swims backward a short distance (its own length or a little more). As it swims backward it revolves on its long axis to the left — in the same direction as when swimming forward. Then it turns on its short axis to its right and swims forward.

2. *Stimulus at Side.*—Identically the same reaction is given as when stimulated at the anterior end; the animal contracts, swims backward, turns to right, and swims forward. The turning is not with reference to the position of the source of stimulus, but is always toward the right side. Therefore, if

stimulated on the right side, the animal turns toward the side stimulated; if on the left side, it turns away from the side stimulated. Owing to the revolution on the long axis while swimming backward, the position of the right side at the time of turning on the short axis bears no definite relation to its position at the time of stimulation; so we find that the absolute direction toward which the animal turns has no constant or prevailing relation to the absolute direction from which the stimulus came.

3. *Stimulus at the Posterior End.* — The posterior end of Stentor, narrowing to a point of attachment, is very little sensitive, so that touching it with the rod of glass usually causes no reaction whatever. By giving it a smart blow, however, a reaction can be induced, and this is then identical with the reaction already described. The animal thus, of course, swims at first *toward* the source of stimulus.

4. *Stimulus not Localized.* — If the vessel containing the Stentors is jarred, they react in the same manner as to localized stimuli.

B. *Chemical Stimuli.*

Stentor gives the same reaction to chemical as to mechanical stimuli. If when swimming forward through the water it comes

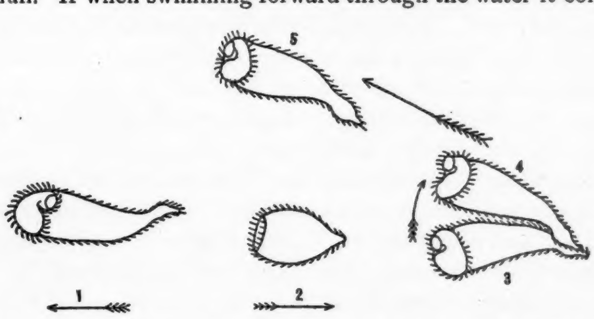

Fig. 4. — Diagram of the reaction of Stentor. The arrows show the direction of motion, while the numbers indicate the successive positions of the animal; No. 1 showing the animal before stimulation occurs.

in contact with a chemical substance sufficiently powerful to act as a stimulus, it contracts, swims backward, turns to the

right, and swims forward on a new path; if this path takes it again into the stimulating region, the reaction is repeated; thus by the laws of chance the animal will in time probably be brought into a region which does not act as a stimulus. The reaction is the same whether the stimulus is localized or is a general one. The reaction is in essentials like that of Paramecium and Stentor.

The reaction of *Stentor polymorphus* is shown in Fig. 4.

SUMMARY AND CONCLUSIONS.

The reactions of Spirostomum and Stentor are similar in all essentials to those of Paramecium. To any stimulus all these animals respond by swimming backward, turning to one side, and then swimming forward. Paramecium and Spirostomum always turn toward the aboral side; Stentor, toward the right side. In Spirostomum and Stentor a contraction of the body forms an additional feature of the reaction. The reaction is not modified in any way by the position of the stimulus; the direction of motion is the same whether the source of stimulus is at the anterior end, the posterior end, the side, or if the stimulus is not localized at all. If the stimulus is at the anterior end, the animal necessarily swims away from it; if at the posterior end, it swims toward it, even when this results in the destruction of the animal. The discussion and conclusions given in my previous paper (*loc. cit.*) in regard to Paramecium are, therefore, equally applicable to Spirostomum and Stentor, and need not be repeated here.

The fact that three such dissimilar ciliates as Paramecium, Spirostomum, and Stentor agree in their reaction in all essential particulars certainly raises a presumption that the mode of reaction is of this general character throughout the ciliate Infusoria. This is especially probable in view of the fact that the revolution on the long axis and progress in a spiral course, which plays so essential a part in these reactions, and indeed seems to have the special purpose of making such a method of reaction possible, is already known to occur in the motions of almost all ciliates. Moreover, the same is known, through the

researches of Nägeli, to be true of the flagellate swarm spores of plants. According to this investigator, such swarm spores swim in a spiral course, with the same side always toward the outside of the spiral — exactly as I have described for Paramecium, Spirostomum, and Stentor. Another observation of Nägeli renders it extremely probable that the mechanism of the reactions of these organisms is essentially the same as in the three ciliates named. When these flagellate swarm spores strike in their forward course against an object, they cease the forward motion for a time, but continue to turn on the long axis; then "there ensues a backward motion, with posterior end in advance, while at the same time they rotate in the opposite direction. This backward course usually lasts but a short time and becomes gradually slower; it is soon exchanged for the forward motion, which takes place, as a rule, in a somewhat different direction from the original one."[1] This description would apply without the slightest change to the reactions of Paramecium, Spirostomum, and Stentor under the same circumstances. It may be predicted with much confidence that the reactions would be found to be similar under other circumstances; that the "somewhat different direction" of the swarm spores would be found to be always toward the side which faces the outside of the spiral course, and that the same reaction would be given whatever the nature and position of the stimulus. If this is true, then the conclusions which I have drawn for Paramecium in my previous paper would apply equally to the Flagellata. Certainly until the mechanism of the reactions of these and other unicellular organisms is determined by observation, it is hardly worth while to base any conclusions on theoretical schemes of the character usually given for such reactions. Theories of the reactions of unicellular organisms may be placed in two general classes: on the one hand are those theories which look upon the activities of unicellular organisms as determined in a manner similar to those of human beings, by a play of desires, motives, etc.; while at the other extreme are theories in which the movements are looked upon as of a character essentially similar to those taking place

[1] The above quotation from Nägeli is translated from Hertwig, *Die Zelle*, p. 66.

in a chemical reaction—the protoplasmic mass reacting rather as a substance than as an individual. Some such theory as this latter seems to be latent in the minds of many biologists; it finds typical expression in the scheme for the reactions of a unicellular organism to chemical substances given by Le Dantec (*La Matière Vivante*, pp. 50–54). In this scheme, which is illustrated by geometrical constructions and almost takes the form of a mathematical demonstration, Le Dantec assumes that there is a tension between the chemical in solution and the surface of the protoplasmic mass, and that this tension acts in lines of force directed either away from the center of the protoplasmic mass, or toward that center. The movement of the organism is then due to the difference in this tension on the two sides of the protoplasmic mass — that directed toward the center from which the chemical is diffusing, and that directed away from it. As the chemical diffuses from a center, the solution is less intense the farther one passes from the center; hence the solution is less dense on that side of the protoplasmic mass farthest away from that center. Assuming that the tension caused by the chemical acts on the protoplasmic mass in lines of force directed away from the center of the mass, it is mathematically demonstrable that this force will be stronger on the side toward the center of diffusion of the chemical, and that the resultant of all the lines of force will be a force directed exactly toward this center of diffusion. Hence the protoplasmic mass will move toward the center of diffusion of the chemical; in this way positive chemotaxis is explained. If, on the other hand, the tension acts in lines of force directed toward the center of the protoplasm, the same mathematical construction shows that the mass will move away from the center of diffusion; thus is explained negative chemotaxis.

The impossibility of reconciling the movements of the three Infusoria, whose reactions I have described, with any such theory as this is manifest. The theory, though designed expressly to explain the movements of the bacteria and flagellates used in Pfeffer's well-known experiments in chemotaxis, neglects entirely the fact of the differentiation, in those organisms, of axes along which movement takes place, as well as the fact that

they move by means of definite organs of locomotion, — flagella, or cilia. To make this abstract scheme fit the concrete motions of the organs of movement would be much more difficult than to invent the scheme.

If chemotaxis acts in the direct manner supposed in such a theory as the above, the organism will of course move directly toward a source of attractive stimulus, directly away from a source of repellent stimulus, and that moreover without regard to the relation of the direction of its axes to the direction of motion. As I have shown in detail for Paramecium (*loc. cit.*), and briefly above for Spirostomum and Stentor, this is by no means true for the organisms studied. On the contrary, the direction of motion has no relation to the position of the source of stimulus, so that we cannot correctly speak of attraction or repulsion at all. The organism reacts *as an individual, not as a substance*, and the nature of the reaction is conditioned by the internal mechanism and the structural differentiations of the body of the organism. The essential distinction insisted upon by Le Dantec (*loc. cit.*) between the reactions of a unicellular organism and those of a metazoan must therefore, for these organisms at least, fall to the ground. It will not do to think of the reactions of these organisms as in any way akin to those of chemical substances.

On the other hand, the reactions are equally distant from the complexity assumed by those who attribute to unicellular organisms most of the psychological powers of higher animals. The reactions of these organisms may best be compared with the working of a machine in which the wheels are geared to turn in but one direction, whatever be the nature of the force that sets them in motion.

Dartmouth College, Hanover, N.H.,
February 28, 1899.

VACATION NOTES.

II. The Northern Pacific Coast.

DOUGLAS HOUGHTON CAMPBELL.

The traveler journeying by rail from northern California into Oregon soon finds himself in a very different country from that which he has left to the south. On emerging from the densely wooded canyon of the upper Sacramento, the railroad climbs up to a nearly level plateau, from which rises the great cone of Shasta. The plain is almost destitute of trees, and presents much the appearance of the prairies east of the Rockies. The slopes of the mountains are well wooded, and the deep valleys between the ridges support a heavy growth of timber. The railway skirts the base of Shasta for several hours, and affords admirable views of the mountain from nearly all sides. Finally the Siskiyou Mountains, the boundary between California and Oregon, are surmounted, and the train descends rapidly into the fertile, well-watered valleys of Oregon. Flourishing fields of grass and clover, and apple orchards remind one of the eastern states, and replace the vineyards and prune orchards, or the fields of alfalfa, of central California.

Following the great Willamette valley, we finally reach Portland, and a few more hours bring us to Tacoma, whence our steamer sails for Alaska. Before Portland is reached, the great Douglas fir begins to predominate in the forest, and about Puget Sound often almost entirely makes up large tracts of forest. Here, too, it reaches its greatest dimensions, it being claimed that about the base of Mt. Rainier there are trees over 400 feet in height. As this is the staple timber tree of the northwest, most of the trees have been cut away from near the settlements, and one must go some distance away to find the virgin forest. This tree, fortunately, like many other western conifers, grows up quickly after the forest has been cut

over, and is rapidly taking possession of the cleared ground, where this has been left for a short time, so that the renewal of this most valuable timber ought not to be a difficult problem, and with little care a supply of timber could be maintained. The heavy rainfall and moderate climate of the coast region induces a very rapid reforesting of the cut-over tracts, which very soon become dense thickets of vigorous young trees.

Two days were spent very pleasantly in Tacoma, which is most attractively placed on the high shore of Puget Sound, with a magnificent view of the Cascade Mountains, and Mt. Rainier, the grandest of all the great snow peaks south of Alaska — indeed, to me it is the finest mountain I have ever seen. The rugged cone, recalling in form that of the Jungfrau, is even more imposing than Shasta, and being seen from the level of the sea, it loses nothing of its 14,000 feet of height.

The luxuriant growth of all kinds of vegetation about Tacoma testifies to the heavy rainfall of this region, and during my stay, both going to and returning from Alaska, rain fell much of the time. In spite of the rain, however, several trips were made in the neighborhood, which is very attractive.

The character of the country about Tacoma varies remarkably within a short distance. To the south are open regions, recalling the oak openings of northern Illinois or southwestern Michigan. The dry ground is covered with a thin growth of grasses or low thickets of ferns, brambles, and other low shrubs, with here and there clumps of scrub oaks — probably *Quercus lobata* — and a few stunted firs. The showiest flower of this region was a handsome small turk's-cap lily, with orange-red, spotted flowers. The common bearberry, *Arctostaphylos uva-ursi*, was common, the spreading mats of glossy green foliage being extremely ornamental.

The site of the town itself was formerly covered by a dense fir forest, remains of which may still be seen in the outskirts. When I arrived, in mid-June, the gardens were beautiful with the early summer flowers. Superb roses grew in the most luxuriant profusion, and were in their prime. I was told that a few weeks earlier the rhododendrons had been equally fine.

The most attractive place in the neighborhood is Point Defiance Park, a government reservation which is open as a public park. It is a magnificent tract of forest, on the shore of the Sound, which has been preserved, and is of course especially interesting to the botanist, as it gives an excellent idea of the character of the forest which formerly covered the whole of the surrounding country. The trees are for the most part the prevailing Douglas fir, and while these do not grow so thickly as in the best lumber regions, still the individual trees are magnificent specimens. Some of them must be 250 feet high, with immensely tall trunks eight feet or more in diameter near the ground. These straight columns run up to a prodigious height without branches, and one only realized the great size of the trunks on coming close to them, as their enormous height gives them a deceptively slender appearance. I was told that these trees were not to be compared to some of those further inland, but they were the finest specimens of the species that I have ever seen.

A few cedars and hemlocks were mixed with the firs, but neither were of remarkable size, although at Vancouver I remember seeing cedars of gigantic size. The undergrowth of the forest was much like that in northern California. The commonest of the deciduous trees noted were *Acer macrophyllum*, *Cornus nuttallii*, and *Alnus oregana*. The excessive moisture causes an extraordinarily rank growth of ferns and undershrubs, almost tropical in its luxuriance. *Pteris aquilina* grew everywhere, some of the fronds being ten feet or more in height, and *Rubus nutkanus*, growing with them, was almost as high. In the low grounds *Equisetum maximum*, five or six feet high, was conspicuous. A few specimens of Linnæa were seen, and another characteristic plant was *Gaultheria shallon*, in full flower. It forms a prostrate bush a foot or two in height, a veritable giant compared to the eastern wintergreen.

At Tacoma I had the good fortune to meet Mr. Walter Evans, of the Department of Agriculture, who was also bound for Alaska. I am much indebted to him for information concerning the flora of the Northern Pacific Coast, with which his former trips had made him familiar.

The voyage to Alaska from Puget Sound is a most attractive one, and during the brief summer season is yearly drawing a larger number of tourists. Last summer, however, the majority of the north-bound passengers were drawn by other attractions than the charms of the scenery, and our passenger list was made up largely of persons bound for Skaguay and Dyea, *en route* for the Klondike.

The route follows the channels between the numberless islands off the coast of British Columbia and Alaska, and at no time do the steamers enter the open sea. Often the channel is so narrow that one could almost throw a stone ashore, and it is hard to realize that one is not sailing through a lake, or even a river, as there is no trace of the ocean swell nor heavy waves, except at one or two points where, for a short distance, there is a break in the barrier of islands protecting the inland channel.

Everywhere the shores are heavily wooded to the water's edge — indeed, the whole coast from Puget Sound to Sitka is covered with an almost unbroken forest, where the trees stand so close together that the dead trees are held upright by their living companions. These bleached skeletons, seen everywhere in the forest, give to it a very peculiar aspect.

Above the timber line the rugged tops of the mountains project, with here and there masses of snow, which become larger and more numerous as we go northward, and come down until they meet the forest. From the steep mountain sides little streams rush down in a series of cascades, which finally fall into the sea.

As we proceed northward the scenery grows more and more striking. The mountains become higher and more rugged, and the summits are completely covered with perpetual snow and ice, and the snow-line descends farther and farther, until finally we reach a land of glaciers, many of which come down to the sea. The wonderful panorama of snow-clad, glacier-sculptured mountains reaches its climax on the last day of the voyage, passing through Lynn channel after leaving Skaguay, the most northerly point visited. Here the mountains rise abruptly from the water to a height of 8000 feet and more,

and from them the great glaciers flow down, sometimes reaching the sea, where the great fragments broken off float off as icebergs. None of the ice masses seen were of very large size, but their fantastic shapes, and the exquisite hues of the pure ice, presented a beautiful spectacle. At this high latitude, at the end of June, the sun did not set until nearly ten o'clock, and it did not become really dark at all, so that we had to go to bed by daylight — a novel experience for most of us.

Stops were made at Wrangell, where there were standing a number of the curious totem poles, which unfortunately have since been burned. Stops were also made at Juneau and Skaguay, the latter a most unattractive collection of shabby huts, raised on piles to keep them out of the water. Near by was the rival town of Dyea, which we did not visit.

The vegetation is everywhere luxuriant, showing the heavy rainfall and relatively mild climate of the coast. The variety of plants, however, is not very great, and as our stops were not of long duration, the opportunities for botanizing were somewhat limited, and no plants were seen which were not also found later at Sitka.

Sitka offers many attractions to the tourist, being most beautifully placed on Baranoff Island, one of the largest of the innumerable islands making up the Alaskan archipelago. Evidences of the Russian occupation are seen on all sides, nearly all the buildings in the little town dating back to the period when this was Russian territory. The massive buildings of hewn logs, with steep moss-covered roofs, and the Greek church lifting its turnip-shaped green cupolas above the other buildings at the head of the main street, give the town a very foreign air, which is not lessened when we find how many of the Russians still remain. The bulk of the population is still made up of the Russians and the native Indians, whose quarter, facing the harbor, presents a picturesque medley of big dug-out canoes, and frames for drying fish, among which are snarling and fighting a rabble of wolfish dogs, which seem to be a necessary adjunct of every self-respecting family of Alaskan Indians.

The harbor is surrounded by mountains on which the snow lies for most of the year, and there are numerous wooded islands

scattered over it which add much to its beauty. The country about Sitka shows a good deal of variety of surface and elevation, and the flora for so northerly a region is decidedly rich. A good road following the harbor for some distance, and several trails, make it easy to get about in the neighborhood of the town itself. The favorite walk is along the beautiful Indian river, which is crossed by a suspension bridge, and along which are most attractive paths through the forest.

The predominant tree of the Alaska forest is the tide-land spruce (*Picea sitchensis*), which forms extensive forests everywhere along the coast south of Sitka. About Sitka the tree reaches a large size, some trunks measured being upwards of twenty-five feet in circumference at about five feet above the ground, and these trees were at least 150 feet high. Like the California redwood, the tree is very tenacious of life and sprouts freely from the stump, as well as springing up quickly from seed, so that when this forest is cut over there soon grows up a dense thicket of young trees. Many trees have the base of the trunk much swollen, and sometimes with a space between the roots, so that the tree is raised, as it were, on stilt-like props. The origin of these peculiar structures is found in the frequent sprouting of the seeds on old stumps or prostrate trunks. These resist decay for many years, and trees of very considerable size are often met with, perched astride of the old fallen trunks, and sending down large roots which finally reach the earth. When the old trunk at last decays, the young tree is left supported by a hollow arch of roots, which often never becomes entirely filled up by subsequent growth.

In the more remote regions two species of cedar (*Thuja plicata* and *Chamæcyparis nutkænsis*) are found, but about Sitka most of the cedar has been cut, as it is in great demand for making the big dug-out canoes, as well as for other purposes. The northern hemlock (*Tsuga mertensiana*) is common about Sitka, and reaches a large size, although hardly equal in size to the spruce. It closely resembles the eastern hemlock, especially when young.

Owing to the excessive moisture, the ground in the forest, as well as every stump and fallen tree, is covered with a thick

carpet of beautiful mosses and liverworts, comprising numerous species. Various species of Hypnum are the commonest, but Polytrichum, Mnium, and others of the larger mosses were conspicuous. Of the Hepatics, the cosmopolitan *Pellia epiphylla* and *Conocephalus conicus* were the most abundant, but there were a number of others which were common. Lichens also were abundant and conspicuous.

The mossy carpet was brightened with many charming flowers, mostly common northern genera. Linnæa, *Smilacina bifolia*, *Cornus canadensis*, Moneses, and various Saxifragaceæ were abundant, and in addition to these were beautiful ferns and the glossy fern-like leaves of Coptis sp.? Most of these woodland flowers showed the white or pale pink color of so many of our vernal flowers, but there were a few of more vivid colors. The bright red and yellow columbine (*Aquilegia formosa*) was common, and a very handsome violet-purple iris, probably *I. sibirica*, was seen in some of the gardens, but was not met with growing wild, although it is said to be common in some parts of Alaska.

Along the edges of the forest and in the clearings were thickets of the salmon-berry, *Rubus speciosus*, whose crimson flowers and big snowy orange and scarlet berries make it the handsomest of its tribe. The fruit is not unpalatable, but is far inferior in flavor to the ordinary red raspberry or the blackberry. They are highly prized by the natives, who preserve large quantities for winter use. Several other species of Rubus are common, as well as various Vacciniums and species of wild currants, all of which are important articles of food among the Indians.

Certain plants were noticed on some of the islands which were not seen about the town. Of these the most noteworthy were *Campanula rotundifolia*, which was very fine on one of the islands, popularly called "blue bell island"; *Rubus nutkanus* and *Fritillaria kamtschatcense* were also collected, the latter, however, past flower.

The low ground in the neighborhood of Sitka is largely covered with a growth of Sphagnum, and, as usual with peat bogs, harbors many interesting plants. In a small lake back of the

town were a number of aquatics, the most conspicuous of which was *Nuphar polysepalum*, with enormous yellow flowers and big leaves. In the Sphagnum grew Linnæa, cranberries, *Vaccinium vitis-idæa*, crowberry, *Drosera rotundifolia*, Menyanthes, and the closely related *Nephrophyllidium crista-galli*, cotton grass, *Kalmia glauca*, and other characteristic bog plants.

On the higher portions of the bog were small groves of *Pinus contorta*, the only pine seen in Alaska, and some small cedars (probably Chamæcyparis), which, not being in fruit, could not be positively identified.

The most conspicuous bog plant of this region is the western skunk-cabbage (*Lysichiton kamtschatcense*), which abounds everywhere along the Northern Pacific Coast, and is the only Aroid of this region. The enormous leaves, sometimes three feet in length and a foot wide, resemble some tropical plant, and recalled to me some of the great West Indian species of Anthurium. Indeed, both the leaves and the inflorescence, with its large, lemon-yellow spathe, recall Anthurium rather than Symplocarpus, with which it is ordinarily associated. The popular name is rather a libel on this very handsome Aroid, as the odor is not at all noticeable.

There are certain drawbacks in exploring the forest, which is so dense that it is not safe to leave the trails. A few feet away from the trail there is an almost impenetrable jungle, the ground covered with fallen logs and a tangle of dense undergrowth which makes one's progress toilsome in the extreme, and once out of sight of the trail the danger of losing one's self completely is very great. The appropriately named "devil's club" (*Echinopanax horridus*), a comely enough plant to look at, with its big, bright green maple-shaped leaves, but whose stem is covered with bunches of needle-like spines, abounds everywhere, and is the veritable terror of these northern woods.

In the more open ground, grasses of various kinds flourish, among them timothy, orchard grass, blue-grass, as well as red and white clover, which are completely naturalized, and would doubtless furnish good feed for horses and cattle, although the

excessive dampness of the climate must render the curing of hay a serious problem.

As might be expected, the mild, moist climate is favorable to the growth of most of the lower plants. Ferns are abundant and in considerable variety, considering the high latitude. No exact list was made, but there are probably a dozen species about Sitka. *Pteris aquilina* is not so common as it is farther south, but several species of Asplenium and Aspidium were very abundant, and *Asplenium filix fœmima* was especially luxuriant, with fronds five or six feet high. On the rocks near the shore a Polypodium (*P. falcatum ?*) was common, and in the woods, besides the ferns already mentioned, the common beech fern (Phegopteris) and the striking *Blechnum spicant* were abundant. Alaska is the only region in America, so far as I know, where the latter common European fern is found. The only other Pteridophytes noted were *Equisetium arvense* and *Lycopodium annotinum*, which was not, however, abundant.

Fungi abounded, but no special notes were made in regard to them. The most conspicuous parasitic one was an Exobasidium, probably *E. vaccinii*, which was very common on Menziesia, where it formed remarkable distortions both of the twigs and leaves, as well as the flowers. These gall-like growths, whether of the leaves or flowers, are usually quite destitute of chlorophyll, and of a pale pink color, with a delicate frosty bloom, caused by the spores of the fungus. The whole region promised a rich harvest to the mycologist.

Very little was done in the way of collecting fresh-water algæ, but material gathered in the bog pools showed many beautiful desmids and other interesting forms. The marine flora is exceptionally rich in the larger brown seaweeds, the Laminariaceæ being specially conspicuous and represented by many genera and species. The large kelps, like Nereocystis and Macrocystis, grow much higher up than they do farther south, and are correspondingly shorter. The tides are very marked at Sitka, and it was striking to see how near the high-tide mark many of the brown algæ grew. Fucus, especially, grew where it was covered by the tide for a very little while, remaining exposed for much the greater part of the time. The

moderate temperature of the air and the prevalence of cloudy skies no doubt favor this habit. These northern waters are especially rich in the gigantic kelps, so characteristic of the Pacific, and the masses of these big brown seaweeds attract the attention of the most careless observer.

After two weeks spent most pleasantly at Sitka, the steamer was taken for the return voyage. On the way back we put into Glacier Bay, where a morning was spent scrambling over the moraine of the great Muir glacier, which fills up the head of the bay, and whose sheer cliffs of glittering ice extend for more than a mile across it, and rise two or three hundred feet above its waters, gray with the detritus of the glacier, from which great blocks of ice are constantly falling to add to the fleet of icebergs sailing out from the bay into the ocean. For many miles back of the ice cliffs the rough surface of the glacier extended to the bases of the snow-capped peaks, which formed the impressive background of this magnificent picture. The face of the glacier presented a marvelous variety of color. In places the cliffs of ice were pure white, with faint blue veins looking like marble, while at other points crags of crystalline clearness glittered in the sunlight with all the tints of the rainbow. The crevasses were of the purest blue, ranging from faint turquoise tints to the deepest sapphire and indigo. Now and again a fragment would break off and fall with a thunderous crash into the bay, where its weight would carry it far below the surface, whence it presently emerged with a great splash like some huge monster, and presently started oceanward to join the rest of the iceberg fleet. Most of these floating ice masses were very free from dirty surface ice, and looked like huge blocks of blue-veined marble, or sometimes were solid masses of pure blue ice of the most exquisite shades.

The huge moraine flanking this glacier presented a most forbidding appearance, and very little vegetation has succeeded in gaining a foothold. Besides a dwarf prostrate willow, a few inches high, which was seen in several places, the only other plant noticed was an Epilobium, the finest of the genus that I have seen. The deep crimson flowers, twice the size of those of the common willow-herb, were magnificent and especially

striking, growing as they did by themselves in the stony wilderness of the moraine.

The return voyage is rather an anti-climax, as the scenery grows less impressive as we go southward. The last day of the voyage, however, afforded us one more impression to carry away. Going north, we had missed the fine view of Mt. Baker, off Victoria. This is the most northerly of the group of snow peaks to be seen from Puget Sound. As we approached Victoria late in the afternoon, we saw far away to the southeast the perfectly symmetrical cone, standing quite alone and reflecting the afternoon sunshine from its smooth slopes, and rising apparently directly from the sea. Two years before I had seen this mountain under similar conditions as we sailed out of Victoria, bound for Japan; and one who has seen the peak of Fuji Yama, on the other side of the Pacific, must be struck with the resemblance between the two mountains. As the light faded on the slopes of Baker we sailed into Victoria and our voyage was over.

As might be expected from its position, the flora of maritime Alaska combines characters both American and Asiatic. While many of the plants were the common sub-arctic types, some like *Pinus contorta* and *Tsuga mertensiana* are distinctly American; while, on the other hand, *Picea litchensis* is found on the northern Pacific coasts of both Asia and America, and a number of the herbaceous plants, *e.g.*, Lysichiton, Fritillaria, *Trientalis europæa*, *Blechnum spicant*, are probably all immigrants from Asia. The continuous chain of the Aleutian Islands connecting the two continents makes the presence of these Oriental immigrants readily understood.

IS THE WHITE RIVER TERTIARY AN ÆOLIAN FORMATION?

W. D. MATTHEW.

WHEN the Cenozoic of the Great Plains of western North America was explored in the fifties and sixties, the theory was formulated that it was deposited as sediment in a succession of vast fresh-water lakes. This view was generally held until the recent explorations, especially under auspices of the United States Geological Survey, which have caused it to be considerably modified. The Loup Fork has been shown to be largely a flood-plain deposit, the Pleistocene chiefly æolian; and Mr. Darton has lately traced an extensive system of river deposits overlying the White River clays. The main body of the White River formation, consisting of fine-grained calcareous "clay," or chalk, with intercalated beds and lenses of sandstone, usually of limited extent and in subordinate amount, has, I believe, been universally considered lacustrine.

There are some very serious difficulties, stratigraphic and paleontologic, in the way of this theory, and observations in Kansas, Nebraska, and Colorado, during the last two summers, suggested to the writer another view, which appears to do away with these difficulties.

OBJECTIONS TO THE LACUSTRINE HYPOTHESIS.

I. *Stratigraphic.*—(*a*) We must assume the former existence of a vast lake covering a large part of Nebraska, Colorado, Wyoming, South Dakota, and perhaps extending even farther northward, with an area dwarfing into insignificance any existing lake. We must assume an eastern and southern barrier high enough and extensive enough to hold in these waters during the entire Oligocene period, which yet entirely escaped

erosion, and subsequently disappeared, leaving no trace, direct or indirect, of its former existence.

(*b*) So large a lake should surely have left strongly marked wave-cut terraces on its shores and islands. I have never seen or heard of any such (as distinguished from wind-cut terraces), although the short-lived glacial lakes gave rise to abundant evidence of this sort.

(*c*) There is a general absence of minute stratification in the clays. They contain heavy beds or layers of different color or hardness, but no fine stratification or horizontal cleavage. The Niobrara Cretaceous, composed of equally fine material, not very different in composition, shows a marked contrast in this respect, fine stratification being universal.

II. *Faunal.* — These difficulties are yet more serious.

(*a*) There are no plants — tree trunks, stems, or leaves — in the clays, although these deposits are well fitted to preserve them. The plant remains that I have seen are limited to the coarser (fluviatile) beds above. Plant remains have been described from the "Bad Lands of Dakota,"[1] but I do not know their exact occurrence.

(*b*) There are no aquatic invertebrates.

(*c*) There are no fish.

(*d*) There are no aquatic reptiles; but land tortoises[2] are the most abundant fossils found, and lizards and snakes occur in considerable variety. The only exceptions to this statement, as far as I know, are a crocodile skull and two specimens of Trionyx, found in South Dakota; but whether in the clays or not, I am uninformed.[3]

(*e*) Mammals occur in great numbers and variety, scattered all through the clays. Of over fifty genera only three are probably aquatic; most of them are land mammals, some are of uncertain habitat. The three aquatic forms are a rhinoceros, Metamynodon, confined to a single layer of *sandstone* in the Oreodon beds, and an oreodont, Leptauchenia, and a beaver,

[1] Lesquereux. *Cretaceous and Tertiary Flora.*

[2] Family Chersidæ, genera Testudo, Stylemys (? = Testudo), — Zittel, *Handbuch von Paläontologie.*

[3] One of the specimens of Trionyx is certainly from the sandstones.

Steneofiber, confined to the probably fluviatile beds at the top of the White River.

The fauna of the clays is, then, exclusively a land fauna. The lacustrine theory requires us to suppose that the animals were swept down by rivers into the lake. Modern rivers do sometimes bring down carcasses of land animals in their floods, along with an overwhelmingly greater amount of tree trunks, leaves, etc., and mingle these with their delta deposits, forming estuarine or delta beds, a well-marked facies of sediments. But the White River clays are not delta deposits; they must, if lacustrine, have been deposited far out in the open lake. How did the land animals get out into this open lake? The current could not take them out, for it was insufficient even to arrange the fine particles of sediment. They might conceivably have floated out. But why in such numbers and so uniformly distributed? How did separate limbs, gnawed, bitten, or weathered bones get there? How did the tortoises get out into the lake? Why were no tree trunks or plant remains floated out, if the animal carcasses could float out? Why are there no fish or invertebrate remains? Contrast this fauna with the Cretaceous, where marine reptiles, fish, and invertebrates are exceedingly numerous, amphibious and land animals extremely rare, and plant remains by no means common. Contrast it with known lacustrine deposits, as some of the small Pleistocene lakes of the east, where fresh-water invertebrates are very abundant, fresh-water fish common, and land plants or water plants, or both, often make up a large part of the deposits, while land animals are rare, except in peat bogs.

If, then, the White River clays are lacustrine, they must have been deposited in an absolutely lifeless sea, surrounded by a well-watered region devoid of vegetation, yet sustaining an animal population of incredible density. And even this combination of improbabilities cannot account for some facts, and does not satisfactorily account for others.

Modern Deposits of the Plains.

There are two kinds of deposition now going on in this region:

I. *River and Flood Plain Sediments.* — Sands and clays are deposited in the valleys whenever continental deformation causes a decrease in the fall of the river bed. Mr. Gilbert's clear exposition of this mode of sedimentation, as exemplified in the Arkansas valley, makes further comment superfluous.[1]

II. *Prairie Loess.* — Wind erosion (deflation), very active in this arid region, carries off from all exposed rock or soil a large amount of material, most of which is deposited on the sodded, or partially sodded, prairie surface. The deposit is heavier in hollows, where temporary "lagoons" or denser grass occur, and tends to produce an extremely level and uniform surface. This deposition through the Pleistocene has produced a fine unstratified, extremely uniform covering of loam (loess or marl) over the greater part of the plains; I have seen it in places two hundred feet thick. It was formerly supposed to be a lacustrine sediment, and that the rivers subsequently cut their channels in the floor of the dried-up lake. It is now, I believe, generally considered æolian, and a significant corollary of the mode of deposition, outlined above, is that it was built up at the sides of the river valleys, deposition in the valleys being checked by erosion; the valleys, therefore, are older than the plains.

Practically the only fossils found in the loess are the bones of land animals. No plant remains occur; the prolonged exposure to water and air permits the nearly complete oxidation of vegetable matter. Near the surface are peaty layers and land shells, but the conditions of burial do not favor their fossilization. Dark lines mark the position of lagoons on the former prairie surface, and slight changes in the quality or fineness of the deposit produce a bedded appearance, uniform over large areas. The extent and uniformity of this Prairie Loess are especially notable. It is the prevalent surface deposit over half a dozen western states in the greater part of the plains region.

[1] *U.S. Geol. Survey, XVIIth Ann. Rep.*, Pt. ii, p. 575.

The occurrence of mammal bones on the surface may be taken as indicating the way they occur within the loess. Skeletons are more or less complete according to the extent of disturbance by carrion feeders. Skulls, limbs, or individual bones are commonly found separated — carried off by other animals. Limbs are very apt to be bitten off across the upper limb bone, leaving the head of the humerus or femur in its socket. Bones are often more or less gnawed or bitten, sometimes weathered, but never water-worn. In and around "salt licks," or lagoons, a mingled heap of bones of many animals is often found, individuals usually hopelessly mixed.

The upper part of the Prairie Loess contains bones of Bison and other modern prairie inhabitants in various early stages of fossilization. The lower part contains Equus bones.

The Æolian Hypothesis.

I believe that the White River clays, in Colorado at least, are chiefly æolian deposits, similar in origin to the Prairie Loess. Most of the sandstones are probably fluviatile, especially those occurring in lenticular masses. The sandstones with the *stratified* clays parallel the modern fluviatile deposits of the valleys. Some sandstones may be æolian.

1. The fauna is what we should expect to find in an open, grassy region. The animals are all land forms, and the most abundant genera, Oreodon, Mesohippus, and Hyracodon, have distinctively *cropping* teeth. The abundant and varied fauna has been supposed to indicate a warm, moist climate; it is paralleled, however, by that of the dry region of South Africa, and the modern fauna of the plains is by no means small. The occurrence of land tortoises cannot be explained by the lake theory, and its explanation of the other land fauna appears an exceedingly improbable one, involving several practical impossibilities, as noted above.

2. The occurrence of specimens is precisely, in every detail, the same as above stated in the modern prairie deposits, and their abundance in Colorado is about the same. Gnawed bones,

bitten off limbs, mixed accumulations in fine uniform sediments, are inexplicable on the lake hypothesis.

3. The character of the clays is exactly what the loess would probably assume on consolidation, and does not agree with the Niobrara chalk, a deposit similar in origin to that proposed by the lacustrine theory for the White River clays, except that the water was salt instead of fresh.

4. The great extent and uniformity of the White River and the details of its distribution appear to the writer to agree with that of the loess, but to be difficult to explain on the theory of lake deposition.

This view of the origin of the White River beds involves a great change in our notions of the climate and conditions of the west in the later Tertiary. If it be correct, these must have been much like those now prevailing in the same region; and our ideas as to the probable appearance and habits of these extinct animals can be made much more definite and certain.

This theory has probably little or no application to the Eocene beds west of the Rockies. These do not contain the fine unstratified chalks; they are in well-defined basins enclosed by mountain ranges and drained by great canyons; land tortoises are as rare in them as water tortoises in the White River; alligators, etc., occur frequently, and the characteristic plains types of mammals of the White River are small, scarce, or undeveloped. Furthermore, before the Sierras and Coast Range were elevated, the rain now falling on the Pacific Coast must have fallen where the Great Basin now is; while we have no *known* adequate cause for so great a change in the climate of the plains between the Oligocene and the present time. The Eocene deposits are probably a mixture of lake and fluviatile sediment—what proportion of each would not be easy to determine.

OVUM IN OVO.

FRANCIS H. HERRICK.

I.

An interesting case of egg within egg recently came to hand, which was unique in this respect: that the smaller enclosed egg lay in the yolk and not in the albumen of the surrounding egg, as in all similar instances hitherto recorded.[1] This hen's egg had unfortunately been cooked. When it was opened, and the white broken into, a suspicious-looking fleck was seen on the surface of the hardened yolk, the removal of which disclosed the imbedded egg. The parts of the containing egg have not been preserved, so that I can record only the general facts here given.

The included egg measures 17×21 mm., is of symmetrical ovoidal form, possesses a hard shell, shell membrane, and small yolk. The shell has a coarse granular texture, and a coffee

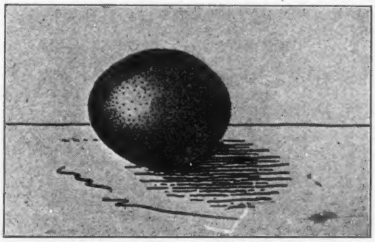

Fig. 1. — Small egg removed from yolk of larger egg. Natural size.

color, sprayed with brown pigment. Its form and appearance are represented in Fig. 1, its relation to the containing egg in Fig. 2.

Since writing the foregoing and following parts of this paper,

[1] I am indebted for this specimen to Mr. Herbert Tetlow and to Mr. E. B. Duffy, by whom it was obtained.

I received a second example of *ovum in ovo*, which is represented in Fig. 3.[1] The smaller enclosed egg lies in the albumen of the larger, as in the cases hitherto described. It measures about 18 × 22 mm., has a clear shell of even texture,

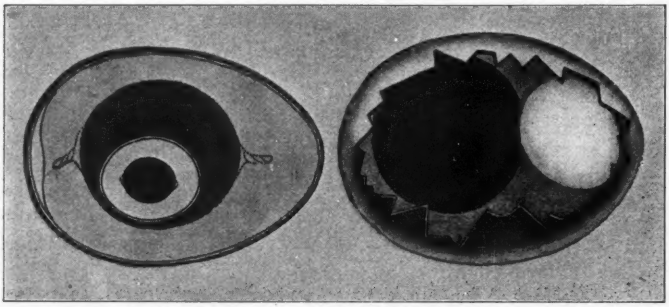

FIG. 2. FIG. 3.

FIG. 2.—Diagram to show the relations of *ovum in ovo*, in which the enclosed egg (Fig. 1) lay in the yolk. This represents the relative form and size of the included egg, and shows its general relation to the yolk of the enclosing egg. In other respects the figure is conventional. Shell, shell membrane, albumen, and yolk are represented in each egg. About four-fifths natural size.

FIG. 3.—Diagram to show the relations of *ovum in ovo*, in which the included egg lay in the albumen. The shell is represented as broken, exposing the yolk shaded dark, and to the right the small enclosed egg, which is white. About four-fifths natural size.

shell membrane, and albumen. Apparently no yolk is present; at least none could be found in the specimen, which has been somewhat mutilated. The parts of the surrounding egg appeared normal in every respect.

II.

These cases belong to that class of abnormalities in the eggs of birds which originate before incubation, and to the variety called *ovum in ovo*. In all recorded cases of this type the contained bodies lie in the albumen, or at least not in the yolk of the surrounding egg.

In 1878 Parona and Grassi[2] described and figured a good

[1] I am enabled to examine this specimen through the kindness of Professor T. H. Morgan.

[2] Sovra alcune monstruosità di uova di gallina, *Atti della Soc. Ital. di Sci. Nat.*, Milano, vol. xx (1878), tav. 2a.

example of the more common condition in which the included egg, an elongated ovoidal body, lay in the albumen. The yolk of the larger egg possessed a normal blastoderm. These writers gave a history of monstrosities of this class known up to that time, from which the following abstracts are drawn.

Davaine, in a work published in 1860, gave a résumé of cases of *ovum in ovo* then known. He found that the enclosing egg might be larger or smaller than normal, having shell, albumen, and yolk, the latter liable to deformity from disturbance of the foreign body. The included egg was very rarely of normal size; usually it was small and devoid of yolk. Clayer, in 1682, described a case where the included egg was very small, but possessed a yolk.

A similar example was also reported by Yung in 1671. The yolk of the inside egg was very small, and possessed two chalazæ. Rayer described, in 1849, a goose egg of colossal size, which contained an egg of normal dimensions, having yolk, albumen, and shell. The outer egg was also complete, although its yolk was flattened by pressure. A few years later three similar cases were reported by De Moroga, Aucapitaine, and Alessandrini. The latter reported the case of an egg of normal size, which contained a small egg complete in all but the shell.

In 1856 a case is cited, by Davaine, of three eggs enclosed by a common shell, and still later a precisely similar phenomenon was described by Flourens.

Panum,[1] who studied for several years the abnormalities of birds' eggs and collected many examples, met with the *ovum in ovo* only once. This resembled Rayer's goose egg, and came from the Indian jungle fowl. The inside body corresponded to the normal egg in size, while the surrounding egg was of relatively huge proportions. Panum adds that in 1858 a remarkable egg of a Cochin China hen was described. It was very heavy and contained two yolks and one ordinary egg with solid shell. Still another egg, analogous to that of Rayer's goose, was described by Bert in 1861. Patrona and Grassi

[1] *Untersuchungen u. d. Entstehung d. Missbildungen.* Berlin, 1860 (cited by Patrona and Grassi).

remark that the foregoing are the only cases recorded of this singular abnormal production, but that it would be possible to cite more than thirty instances in which small yolkless eggs have been found enclosed in another egg apparently normal. Later additions to this literature have been made by Landois in 1882,[1] and by Schumacher in 1896.[2]

Landois remarks that in most cases of *ovum in ovo* the included egg is small and yolkless, and sometimes possesses a very abnormal form. In one erratic individual it resembled a tapeworm, consisting of a button the size of a pin head, followed by a fibrous section, and ending in a broad flattened string. He thinks that most so-called tapeworms in hens' eggs are nothing more than monstrosities of this kind.

In the case described by Schumacher the enclosing egg was apparently normal, and, like that figured by Patrona and Grassi, possessed an egg-like inclusion in the albumen. This was of regular oval form, a little larger than that here described, and, besides hard shell, possessed a stratified albumen, an irregular spirally twisted yolk mass, measuring 8×4 mm., with small chalazæ at either end. There was no blastoderm.

III.

Reviewing the cases of *ovum in ovo* in zoölogical literature, we may classify them in the following manner:

I. Enveloping egg usually normal, but occasionally of large size; blastoderm recorded in at least one instance.

Enveloped egg:

(*a*) In yolk; small; composed of shell, shell membrane, albumen, and yolk; no blastoderm known to occur in this or in the following variations; single case recorded in this paper (Fig. 2).

(*b*) In albumen; small; composed usually of shell, shell membrane, albumen, and rarely with yolk; few cases reported.

(*c*) In albumen; small; usually with shell, shell membrane, and albumen, but no yolk; most cases of *ovum in ovo* reported are of this kind (Fig. 3).

(*d*) In albumen; usually small and variously distorted, so as to bear little resemblance to an egg at all.

[1] *Fremde Einschlüsse in Hühnereiern.* Humboldt, Heft 1 (1882), pp. 22–24.

[2] Ein Ei im Ei, *Zoologischer Anzeiger*, Bd. xix (1896), pp. 366–368.

II. Enveloping egg of colossal size; complete; blastoderm probably present.

Enveloped egg:

(*a*) Without shell, but otherwise complete. In this case a common shell may surround two or three eggs complete except for shells and shell membranes; forming "double-yolk" or "triple-yolk" eggs.

(*b*) One of the enclosed eggs of normal appearance and size, possessing shell, albumen, and yolk; the other eggs surrounded by a common shell, but having no shells of their own.

According to the accepted accounts, the yolk of the fowl's ovum is of normal size when it leaves its vascular capsule in the ovary, and is taken up by the infundibulum. Reaching the oviduct it receives its first layer of albumen, and is carried slowly down the tube by peristaltic muscular contraction of the walls. Near the lower end of the oviduct the final layers of albumen are added, and in the distal extremity of the duct, called the uterus, the shell is formed.

In the opinion of several writers the small included egg represents a fragment of a normal ovum which has been ruptured, and thus has parted with some of its substance after leaving the ovary. This fragment is then treated in the oviduct like a full-sized egg. The small egg-like body thus produced is sometimes laid, but occasionally it is driven by anti-peristaltic action up the tube until it collides and fuses with the mother egg. This theory will suffice to explain the first class of inclusions on the supposition that rupture takes place in the upper part of the oviduct, or at least after the first layers of albumen have been added to the normal egg. Since the small included eggs are generally yolkless, we must infer that such ruptures are, as a rule, confined to the albumen. It seems more probable that the small egg becomes enclosed before the shell membrane is formed over a normal egg, with little if any retrogressive movement. Furthermore, it is possible that any substance which serves as a local stimulus to the upper part of the oviduct, whether coming from the ovary as abortive egg or egg-fragment, or from the duct as secreted product, may serve as a nucleus, about which an egg-like body may be formed. Normally laid eggs, indeed, tend to sweep the oviducal canal

clear of all obstructions, whether they be abortive eggs, blood clots, feathers which rarely grow from its walls, or parasites which find their way into it. These bodies are taken up by the egg, and become imbedded in it. In one of the cases recorded in this paper the obstruction or small "egg" (Fig. 2) has been pressed through the albumen, through the vitelline membrane, and thus into the yolk itself. It is evident that inclusions of the first type are not true eggs in any strict sense, since, so far as known, they contain no protoplasm.

The theory of yolk-hernia will not explain the second class of abnormalities, such as double or triple yolk eggs. We have here a case of fusion of the albumen in two or more ova, which are treated in the uterus as one egg and surrounded by a single shell. This process is sometimes complicated by the inclusion of a third egg of normal size and already covered by a hard shell. These conditions may be brought about by irregularities in the mechanism of the oviduct, as when any given egg does not receive its shell and is not laid before it encounters others coming down the oviduct at the same time.

According to Duval, an egg usually spends thirty hours in the oviduct, twenty-four of which are passed in the uterus, and if the fowl lays once in forty-four hours a single egg will be found in the oviduct at any given time. When the intervals of laying become shorter, however, an egg may be found at either end of the tube. In some of the cases described three ova must have been in the tube and collided there, owing to disturbances in the normal rhythms.

ON THE HABITS AND STRUCTURE OF THE COCCID GENUS MARGARODES.

T. D. A. COCKERELL.

THERE has recently been made a new pathway across the campus of the New Mexico Agricultural College at Mesilla Park, and the earth on it is still soft and loose. Walking this morning (January 16) up this path, I saw, just opposite the door of the new Science Hall, a couple of small winged insects, hurrying to and fro as if they had lost something, almost beneath my feet. Curious to know what was stirring at this time of year, I knelt down, and was surprised to find that they were male coccids. Presently, greatly to my astonishment, one of them began to dig into the earth, and in a moment completely buried itself, leaving only the tips of its long abdominal filaments visible. I dug it out and discovered the object of its search, which was a plump yellow female coccid.

These coccids, ♂ and ♀, prove to belong to the singular genus Margarodes, never before found in New Mexico. This genus was established by the Rev. L. Guilding, in 1829, for a species of the West Indies; others have lately been described by Giard from Chili and the Cape of Good Hope. One form, *Margarodes formicarum* Guilding, var. *rileyi*, Giard, has been found on some of the Florida Keys. An allied genus, Porphyrophora, with several species, occurs in Europe; it was named by Brandt in 1835.

These two genera (if they are to be separated) form the subfamily Porphyrophorinæ or Margarodinæ, closely allied to the Monophlebinæ, and especially to the Xylococcinæ of Pergande. Both Margarodinæ and Xylococcinæ are very well separated from Monophlebinæ by the absence of legs and antennæ in the intermediate stages of the female, and the total absence of mouth parts in the adult female. From one another they do

not differ so much, and I am inclined to treat them only as tribes of one subfamily, thus:

Tribe, Margarodini. Subterranean; anterior legs of both sexes (adults) adapted for digging. Tribe, Xylococcini. Arboreal; anterior legs normal.

The striking character of the adult Margarodes, especially (because least expected) in the ♂, is that of the anterior legs. The ♂ of Porphyrophora has long been known to have short anterior legs; that of Margarodes was quite unknown until lately described by M. Lataste in the *Actes Soc. Scien. Chili*, Vol. VII (1897), pp. 99–102. Lataste's account, relating to *M. vitium* Giard, is quite full, and he gives a figure of one of the curious anterior legs with its thickened femur. Nobody, however, seems to have seen the insects digging until now, nor to have known the purpose of the peculiarity.

The following description will serve for the identification of the New Mexico Margarodes:

Margarodes hiemalis, sp. nov.

Adult ♀. Bright lemon yellow, very soft, oval; 5½ mm. long, 4 broad, 2½ high; segmentation distinct, each segment with a whorl of mostly blackish but inconspicuous hairs; apex of abdomen with a small reddish hairy prominence; abdomen on ventral surface longitudinally sulcate on each side, but the median area bulging, not depressed; a deep median depression between the levels of the first two pairs of legs; thoracic spiracles present as usual, but no abdominal spiracles noticed; mouth parts entirely absent; antennæ short, moniliform, light reddish brown, except segments 1 to 3, which are pallid, 8-segmented; segments 1 and 2 very short, ring-like, fully three times as broad as long, 2 smaller and not so broad as 1; 3 transversely oval, large; 4 very short and broad; the next 3 almost cordiform; the last (8th) spherical; sutures between segments 3 to 8 very deep; 8 with some long hairs at end; skin minutely papillose; a dull pinkish patch between the antennæ; legs present; first pair adapted for digging; femur excessively broad and short, forming a low rounded cone, on which is a shining red-brown rounded structure, divided by a suture in the middle; the basal part of this, which is the tibia, is broader than long; the apical part (tarsus) is continued at its apex into a stout long piceous process, which forms a digging claw. The other legs are similar in structure, but considerably smaller; the claws are all incrusted by a black substance, which on one of the middle legs forms quite a big lump.

Adult ♂. Length of body about 2 mm., of abdominal brush about

5 mm., of wing about 3½ mm. Body purplish brown, eyes and anterior part of prothorax crimson; mesothorax shining dark brown; abdomen with a median longitudinal series of transversely lengthened dark brown or blackish marks; wings ample, clear, iridescent, with a large pinkish pseudo-stigma. Eyes very strongly faceted. Abdominal brushes two, arising from the 7th and 8th dorsal segments, each consisting of many white threads, as in Orthezia. Antennæ brown, 10-segmented, the segments sausage-shaped, except the first two, which are short and broad; each segment with spreading hairs, which, however, are not as long as the segment. The wings have no veins except the costal, but there are three folds; two parallel and close together, obliquely crossing the middle of the wing to the lower margin; and one in the place of the anal vein. Anterior legs fossorial, the femora greatly swollen, like the hind femora of Haltica; tibia and tarsus (the latter short) transformed into a digging claw; middle and hind legs ordinary, except that the hind femora are rather swollen, and the tarsi are all extremely short, hardly one-fourth the length of the long tibiæ. Claws sharp and long; no digitules.

Hab. — Mesilla Park, New Mexico, Jan. 16, 1899. The immature forms remain to be discovered; they will certainly be found on the roots of some shrub; most probably on those of *Atriplex canescens*, which abounds on the college campus; possibly on those of *Prosopis glandulosa*.

MESILLA PARK, NEW MEXICO,
January, 1899.

EDITORIAL COMMENT.

The Gypsy Moth and Economic Entomology.—In the presidential address delivered before the Association of Economic Entomologists, last August, the motives of those who oppose the large appropriations made by the State of Massachusetts for the extermination of the gypsy moth are attributed to "unfortunate jealousy or unreasonable prejudice." In the same address the expression of individual opinion is deplored, and while diversity of view is recognized as an essential of progress, the expression of such diversity before the public is condemned.

The *American Naturalist* has more than once taken ground against the annual appropriation for the extermination of the gypsy moth, and with the keenest appreciation of the objects and aims of sound economic work is prepared to maintain that, given all the money and all the men asked for, the extermination of the insect in Massachusetts is doomed to failure. The public, always slow to accept the results of science, will regard this failure to the detriment of scientific work, and when popular support is needed the claims of science will be discredited. As a recent writer says: "Is it not sometimes the part of wisdom in a prudent business man to let a bad investment go, rather than to lose more money by trying to save what is already lost?"

The gypsy moth problem in Massachusetts may be briefly stated: Introduced in the egg stage in 1868 or 1869, the insect at first escaped general notice; in 1889, however, it caused so much destruction in Malden and Medford that the state was asked, in 1890, to take measures for its extermination. A commission was at first appointed, and served for less than a year; since 1891 the work has been directed by a committee of the State Board of Agriculture. Nearly one million dollars has been expended in the work of extermination. This work, prosecuted with more vigor than judgment, has greatly reduced the damage done in badly infested districts, but has not succeeded in keeping the insect within the original boundaries as defined in 1891. The injury caused by the cutting down of trees and bushes, the wanton destruction, by burning, of birds during the nesting season, and the general tidying up of beautiful wild country roads and ways

are features of the work of extermination that cannot be too strongly condemned. While the work for extermination is approved by the official vote of the Association of Economic Entomologists, it is unfavorably viewed by many eminent entomologists, by most scientific men living in the infested district, and by a large and rapidly increasing number of residents under the eyes of whom the work of extermination is carried on. It is also opposed by one of the original members of the committee appointed in 1891, a man deeply interested in the agricultural welfare of the state and country.

The most effective testimony against extermination and in favor of suppression is the practical experience of a resident of Medford, Mr. Walter C. Wright. Mr. Wright lives in the heart of the infested district, and has upon more than thirty acres of land, the larger part woodland, brought about "a thorough suppression, and the time and expense which have been devoted to the work are not worth naming." Mr. Wright adds: "I should blush to ask state aid for it."

In view of these facts, is it worth while to continue the present extravagant policy? We answer emphatically, No!

The common-sense view—and it was Huxley who said that science is but common sense applied to common things—was pointed out several years ago, and has been frequently repeated. It may be summed up as follows:

1. Abandon the policy of extermination, and turn all resources towards the suppression of dangerous outbreaks.

2. Formulate a law for the suppression of all insect and fungus pests. Employ a corps of men to point out to landowners and to town and city authorities the proper mode of coping with dangerous pests.

If the landowners or the authorities fail to observe the law, after proper notice, the work should be done by the state at the delinquent's charge. To enforce this law the employment of from ten to twelve men, with an annual appropriation of $50,000, will suffice. The work should be under the charge of the State Board of Agriculture.

The advocacy of one view for ourselves and one view for the public requires no comment.

Zoölogical Instruction in German and American Universities.— There is one very marked difference between the German and the American universities in regard to what belongs to the field of zoölogical instruction. In Germany a student would rarely think of going to the professor of zoölogy for instruction in matters relating to the vertebrates. He would nearly always turn to the professor of

anatomy in the medical faculty for direction in such studies, since with few exceptions the professor of zoölogy is interested solely in the non-vertebrate groups or in the problems of cytology. In America the conditions are widely different. The professor of zoölogy here has to cover both vertebrates and invertebrates, while the student who should go to the anatomical departments of the medical schools would get nothing but human anatomy, and absolutely no breadth of view. So far as we are aware there are but two medical schools in the whole United States where this is not true. With but very few exceptions, the professors of anatomy know nothing of any vertebrate except man, but are usually in the position of that professor who said recently, while studying the lateralis branch of the vagus in the shark, that he was all wrong in calling that nerve a branch of the tenth, because the tenth nerve was distributed only to heart, lungs, and stomach. Had our medical schools professors with broader perspectives, the study of anatomy would have more attractions for the students, and the examinations would no longer be puzzles, but would be of value in testing the real knowledge of the student. In many medical schools in this country the stock question asked in examination in osteology demands a description of either the sphenoid or the petrous portion of the temporal bone, regardless of the fact that these bones are of very little practical importance to the future practitioner. We would not urge our zoölogists to narrow their field, but we would recommend to our professors of anatomy that they make their instruction and their studies comparative. Our medical schools are absolutely unproductive in the field of anatomy; almost all work done on the anatomy of vertebrates in Germany is done in the medical departments of the universities.

Aberrant Birds' Eggs.— Some time ago Professor Bumpus showed us that the eggs of the English sparrow in America are variable as well as the adults, and now Mr. J. W. Jacobs points out that the eggs of many of our species vary greatly in coloration, size, and shape. Aberrations of one sort or another are recorded in one hundred and ten species, and several cases are represented by photographic reproductions on two plates. Here is a better occupation than naming new subspecies. We hope Mr. Jacobs's pamphlet will be widely read, and that oölogists will be incited not to gather more birds' eggs, but to *study* the vast collections which have already been made. Mr. Jacobs's pamphlet is entitled "Oölogical Abnormalities," and is published by him at Waynesburg, Pa.

Are Bird Migrations Affected by an Extreme Southern Winter? — The extraordinary cold, combined with snow, which affected the Southern States February 8 to 14, undoubtedly had a very destructive effect on the birds of that region. A correspondent of the *Boston Transcript* sends to that paper the following clipping from the *Charleston* (S. C.) *News and Courier:*

"On Tuesday a gentleman flushed a woodcock in the neighborhood of the City Hall, and a little later in the day a colored man captured one on Broad Street. The poor bird was too cold to make much use of its wings to effect its escape. At Mount Pleasant numbers of them, together with quail, were found near the habitations of men, and caught. They were evidently driven in from the fields and woods by cold and hunger, and thus made themselves easy victims to the pot hunter. More than half a dozen negroes were seen yesterday with large bunches of birds, consisting of quail, woodcock, and doves, which they had found, no doubt, in a partially frozen condition. This illustrates how even the wildest creatures are sometimes driven by extreme cold and hunger to take the most desperate chances in search of food, and how for the time they become as tame as domestic animals and birds. No doubt there will be a great scarcity of game another year, for large numbers of the smaller animals and birds, especially birds, must have perished from the intense cold of the last few days."

Have any students of this spring's migrations noticed any diminution in the number of birds?

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

The Neolithic Period of Human Culture in Northern Africa. — The February number (Feb. 15, 1899) of the *Revue de l'École d'Anthropologie* presents under this title an able article from the pen of Professor Zaborowski, the Archivar of the Paris School of Anthropology.

The author reviews numerous observations and arrives at the conclusion that, during the neolithic period, the peoples of the whole of northern Africa, including Egypt and a large part of the desert, were racially, as well as by their civilization, closely interrelated.

Who these ancient North-Africans were, ethnically, is not certain. Among the most ancient Egyptian skulls there are none of negroes, and hence the prehistoric Egyptians were not Asiatics who invaded new regions, driving away the black indigenes. Later on, negro skulls appear, indicating an early slave trade.

Not much is known yet of the neolithic period in Sahara and Algiers; nevertheless there were known, as early as 1883, seventeen ancient stations in the Sahara, where stone implements were found. The finds generally yielded numerous knives and saws, some arrow points, scrapers, etc., some of the specimens showing considerable art; there were also commonly found fragments of large ostrich eggs, some of these pieces being in the form of ornaments. Also fragments of black ornamented pottery were found. These articles were used at a time when the Sahara was watered by rains and had an abundant vegetation. Near the wells of El-Hassi the specimens lie in a layer of mud, under a layer of sedimentary limestone 50 cm. in thickness.

The stone implements are found principally between Laghouat and El-Golea, at Aïn-Taïba, and in the vicinity of Ouargla. The natives of these places know nothing of the origin of these articles, and declare that they are the weapons of the spirits of the air, the "djinn." Large shops where the implements were made have also been discovered, and in these shops division of labor was noticeable. Axes are extremely rare, and those that are found were probably brought in by trade.

The population of Sahara never attained the density, or the height of culture, of the Egyptians; nevertheless, no line of demarcation between the two peoples is apparent during the neolithic period.

Discoveries similar to those in Sahara were made in Algiers and in Tunis. Oran was particularly rich in specimens. In Tunis the silex stations and shops are quite numerous. In the oasis Métouïa, north of Gabes, Mr. Belucci, in 1875, found over 1700 arms and implements of stone. He also found nearly 3000 specimens at Gabes itself. Since then a number of other important finds have been made in these regions. The characters of the implements are very nearly like those from the Sahara, and similar characters are observed on stone implements from Egypt. Axes and polished articles are rare.

The modes of burial are much alike throughout northern Africa. We meet with several distinct methods. The most ancient burials were like those of many American peoples, the body being buried with its head bent down and the lower limbs folded towards the body — in the shape of the fœtus in utero. This mode of burial occurs from Egypt to the extreme limit of western Africa (Cape Spartel); it is still preserved by the Guanches.

Somewhat later, bodies were buried in cysts or fosses, made from beaten clay or from sun-dried bricks. Still another form of burial consisted in enclosing the body in one or two large earthen jars — a method which was practiced in some parts of Central America. These kinds of burial were also found to be common to various parts of northern Africa. The jar burials are particularly prominent in Tunis and Algiers, where they seem to have been practiced for a longer period of time than in Egypt. At Carthage, jar sepulchres date from as late as the early Punic epoch. This form of burial is also found in parts of Spain, in Corsica, and Balearic Islands. The period of such graves is throughout anterior to the use of iron, though embracing in places the periods of copper and bronze.

Still another class of works which supports the theory of close connection of the prehistoric populations of the whole of northern Africa are the petroglyphs. These are found from Morocco to the Libyan desert. The engravings in the rock are often of large size, and represent the figures of plumed hunters or warriors, and of many animals, some of which have been for a long time extinct in these localities. There are no representations of horses, asses, camels, or sheep, from which it may be concluded that the petroglyphs antedate the introduction of these animals and are very ancient. They are closely allied to the *graffiti* of the higher Egypt and of a part of

the desert (between Edfou and Silsilis). Zaborowski considers these petroglyphs to be symbolical, and for the most part more ancient than the Egyptian hieroglyphs, to the formation of which they possibly led.

Thus the ancient populations of northern Africa present three very important phases of culture in common, namely, similar implements, the same burial costumes, and similar rock-engravings. This establishes the fact that the neolithic populations of northern Africa were closely interrelated, more so than the peoples living in the same regions since the stone period.

It is to be hoped that this excellent dissertation by Professor Zaborowski will soon be followed by a comprehensive study of the osseous remains of the ancient inhabitants of northern Africa.

HRDLICKA.

Prehistoric Art.[1] — In a profusely illustrated monograph Dr. Wilson gives an exhaustive account of our present knowledge concerning the art of prehistoric peoples. "This paper is a contribution to the history of art rather than to the science of art, and is intended as a record of the actual manifestations of art in the various epochs of human culture in prehistoric times, showing the earliest specimens, and thus presenting the idea indicated in the title."

The author has confined his attention to known facts, and submits these as a foundation upon which others may theorize if so inclined. He has rendered a great service to archæology in thus gathering together such a wealth of information, and his profound knowledge and experience in this department of science would have warranted him, if any one, in indulging in speculations regarding the cultural stages indicated by the artifacts described. The work is divided into three sections: I. Paleolithic Period; II. Neolithic Period; and III. Prehistoric Musical Instruments; the last having been prepared jointly with Mr. E. P. Upham.

F. R.

The Lamp of the Eskimo.[2] — This paper is announced to be one of a series upon "heating and illumination from the standpoint of the ethnologist." The uses and importance of the lamp are described,

[1] Wilson, Thomas. Prehistoric Art: or the Origin of Art as manifested in the Works of Prehistoric Man, *Report of the U. S. National Museum* for 1896, pp. 349–664. Government Printing Office, 1898.

[2] Hough, Walter. The Lamp of the Eskimo, *Report U. S. National Museum*, 1896, pp. 1027–1057.

and the fact pointed out that it has probably been the cause of the occupancy of the Arctic regions by the Eskimos — has determined the distribution of the race. It is peculiarly the property of the women, and "a woman without a lamp" is an expression which betokens, of all beings, the most wretched among the Eskimo. Owing to the soot thrown off, the lamp renders it impossible for the Eskimo to be at all cleanly in the igloos. The lamp fulfills several functions, one of the most important of which is to melt snow and ice for drinking-water. There are three kinds of lamps: house lamp, traveler's lamp, and mortuary lamp. About a dozen types are described, from the East Greenland lamp to that from Siberia. In both the Labrador and the Mackenzie River type it would seem to us that the author has attempted to establish a "type" from too small a series. The Peabody Museum of Harvard University contains several large Labrador lamps from Hopedale, which have divided bridges, and thus differ somewhat from the two types accredited to that region. But the significance of the paper lies in its demonstration of the effect of a technic art upon a hunting race; it is a contribution to the final "Weltgeschichte."

F. R.

Chess and Playing Cards.[1] — Though it has developed from a simple catalogue and purports to be but a preliminary work, this memoir of 263 pages, by Stewart Culin, contains a valuable store of information concerning games and divinatory processes. In the words of the author, "The object of this collection is to illustrate the probable origin, significance, and development of the games of chess and playing cards." "The basis of the divinatory systems from which games have arisen is assumed to be the classification of all things according to the four directions. This method of classification is practically universal among primitive people both in Asia and America. In order to classify objects and events which did not in themselves reveal their proper assignment, resort was had to magic. Survivals of these magical processes constitute our present games. The identity of the games of Asia and America may be explained upon the ground of their common object, and the identity of the mythical concepts which underlie them. These concepts, as illustrated in games, appear to be well-nigh universal. In the classification of things according to the four quarters we find a numerical ratio was assumed to exist between the several categories. The dis-

[1] Culin, Stewart. Chess and Playing Cards, *Report of the U. S. National Museum* for 1896, pp. 665–942. Washington, Government Printing Office, 1898.

covery of this ratio was regarded as an all-important clue. The cubical dotted die represents one of the implements of magic employed for this purpose. The cubical die belongs, however, to a comparatively late period in the history of games and divination. The almost universal object for determining number, and thence, by counting, place or direction, is three or more wooden staves, usually flat on one side and rounded upon the other." The author offers no comments upon the games of Patolli, of Mexico, and Pachesi, of India, which are perhaps the best examples of resemblance in a somewhat complex game from widely separated regions. It will be remembered that Dr. E. B. Tylor, to whose paper he refers, considers the game of Patolli to have been derived from Asiatic sources. The work is illustrated with fifty plates and over two hundred figures in the text.

F. R.

The Huichol Indians of Mexico.[1] — Carl Lumholtz has given a preliminary sketch of the Huichol Indians of the state of Jalisco, Mexico, whom he visited in 1894. But brief mention is made of their physical characters. The average stature of 43 men measured was 1.65 meters. They are thievish, emotional, imaginative, excitable, avaricious, and yet not inhospitable when their confidence has been gained. They spend a great part of their time at feasts and ceremonies. The houses are of stones and mud, covered with thatched roofs. The drinks used and the manner of brewing and distilling them are described in some detail. The author considers the process of distillation to be the most primitive in use upon the continent.

F. R.

Anthropological Notes. — In the *Annual Report of the Director of the Field Columbian Museum* for the year ending Sept. 30, 1898, we note that the Department of Anthropology was one of the most active and successful in the museum during the year. The accession list contains a rather undue proportion of osteological specimens — rather a fortunate condition from our point of view.

In the January–February number of the *American Antiquarian* H. I. Smith gives an interesting list of the "Animal Forms in Peruvian Art." The animals represented range from man to mollusks, and are both painted and sculptured.

[1] *Bulletin of the American Museum of Natural History*, vol. x, article i, pp. 1–14. New York, 1898.

In an able review of "Notes of the Folk-Lore of the Fjort" (R. E. Dennett), Mr. Newell, in the October–December number of the *American Folk-Lore Journal*, calls attention to the fact that in the publication of this work the Folk-Lore Society places itself on record as accepting his definition of the scope and meaning of folk-lore. It is not to be confined to survivals of custom and belief among enlightened races, but is to include all oral tradition of all periods and all cultures.

In the *Ann. de la Soc. Esp. His. Nat.*, ser. 2, tome vi, is published a bibliography of anthropological literature relating to the Spanish peninsula for the years 1896 and 1897. Sr. Hoyos has given 113 titles for the former year and 127 for the latter. They are classified under the following heads: general anthropology, ethnography, and sociology, linguistics, and prehistoric and protohistoric archæology. They are further classified according to the provinces to which they refer.

Marquis de Nadaillac, in the November–December number of *L'Anthropologie*, gives an extended review of an "Introduction to the Study of North American Archæology" by Cyrus Thomas. His distinguished investigations in this field entitle him to speak with authority concerning all that pertains to prehistoric America. He justly observes that the subject is one of great interest because of the obscurity enveloping it, and, in conclusion, "the past of America is still an unfathomable mystery."

In the *Smithsonian Report* for 1896 will be found a description of the "Biblical Antiquities" that were exhibited at the Atlanta Exposition in 1895. This illustrated paper is of special interest to students of "Ceremonialism."

F. R.

GENERAL BIOLOGY.

Professor Ewart's Mares.[1] — Lord Morton's mare has played its part in the literature of speculative biology for nearly eighty years, and deserves a rest. It is most likely to get it through the researches of Professor Ewart, who is conducting telegony experiments on a large scale at his farm at Penycuik [pronounced *pennycook*]. Since the

[1] Ewart, J. C. *The Penycuik Experiments.* London, Adam and Charles Black, 1899. xciii + 177 pp., 46 figs.

quagga, which Lord Morton used in "infecting," is now an extinct species, Ewart uses zebras. He has bred, up to the time of writing, nine zebra ♂ horses, ♀ hybrids, and three reciprocal hybrids. In two cases he has crossed a mare with a zebra, and then obtained a second foal from the mare mated with a horse. In one case there were quite marked stripes; in the second case there were faint and few stripes. In two other cases a mare which had already had foals by a horse and then by the zebra, had a third foal by a horse, and this foal was unmarked. Ewart does not regard the stripes seen in the first two cases good evidence for telegony, because of the frequency with which such stripes occur on pure-bred foals. He finds that foals are far more often marked with stripes — apparent or real — than is generally supposed, and that stripes will be often seen in horses if they are carefully looked for. Ewart is continuing his experiments; but it seems as though the fact that even marked stripes may occur in normally bred foals will interfere with getting a satisfactory conclusion concerning telegony in horses.

Common Salt a Plant Poison. — A solution may have either of two injurious effects: it may act osmotically and withdraw from the protoplasm the necessary water; it may act chemically. Sodium chloride has usually been regarded as acting osmotically only. Now True[1] shows that when a solution of sodium chloride or potassium nitrate is made of the same osmotic value as a sugar solution, it is far more injurious than the sugar solution. This can only be interpreted to mean that the salt has some additional effect above the osmotic effect, and this can only be a chemical one.

Physics and General Biology.[2] — The naturalist has frequent need of a good physics. We therefore take pleasure in noticing a new text-book on this subject by two professors at Yale University. The treatment, while quantitative, does not involve the use of calculus. Of most use to the naturalist will be the sections on instruments for measuring time and length; tables of densities of gases at various temperatures and pressures and of solids and liquids; surface tension, to which an entire chapter is devoted; solutions (including a fairly full treatment of osmosis); electric cells and galvanometers;

[1] True, R. H. Physiological Action of Certain Plasmolyzing Agents, *Bot. Gazette*, vol. xxvi, pp. 407–416, December, 1898.

[2] Hastings, Chas., and Beach, F. K. E. *A Text-Book of General Physics*. Boston, Ginn & Co., 1899. viii + 768 pp., 495 figs.

the electric theory; waves, especially sound waves; the physical theory of hearing and musical instruments; and valuable chapters on Elementary Theory of Optical Instruments, Spectroscopy, and Maximum Efficiency of Optical Instruments.

The Plankton of the Limfiord.[1] — This fiord is a tortuous channel, 92 miles in length, which traverses the peninsula of Jutland. In 1825 an irruption of the North Sea drove back the fresh and brackish water fauna of the fiord and replaced it with that of the sea. A slow current passes through it from the east or the west according to the relative levels of the North and Baltic Seas, though in recent years it has been predominantly from the North Sea eastward. The stream is shallow — 2–13 fathoms — with a few expansions in shallow lakes, and exhibits practically uniform conditions of temperature and salinity at the top and the bottom. Owing to the slight depth the temperature rises to 18.4° C. in the summer, and the salinity averages about 3 per cent. The plankton of this interesting region has been investigated by Dr. Petersen of the Danish Biological Station. Three traverses of the fiord were made in 1896 and 1897, and the collections thus made were supplemented by a seasonal series and by others from the Cattegat and the Baltic. The qualitative examination, made by Mr. H. Grau, was confined in the main to the diatoms and the Peridinieæ, which constitute the bulk of the plankton. The investigation determined that the amount of plankton per □ meter in the shallow fiord was 10–50 times as great as that of the adjacent and deeper North Sea, and more than double that of the Cattegat. The constitution of the plankton is peculiar in that the predominant species are neritic rather than oceanic, and are not thus abundant in the North Sea, whence the fiord receives its water, nor in the Cattegat, into which it empties. Its diatom flora must therefore breed in the water in transit in response to some change in the physical-chemical environment, as, for example, contact with the bottom, rise in temperature, or the addition of nitrogen by the tributary rivulets. Another instance of this unique phenomena — namely, the maintenance of a peculiar plankton at a given point in a body of water traversed by a current — was discovered in the Cattegat, where an undercurrent from the deeper Skager Rack enters this shallower area, and there is developed within it, in passing, a local and peculiar diatom flora. The results of this work lead the author to suggest that "guide

[1] Petersen, C. G. J. Plankton Studies in the Limfjord, *Rep. Danish Biol. Station*, vol. vii, 1897. 23 pp., with 1 map and 4 tables. 1898.

organisms" from the plankton for the detection of oceanic currents, especially with changing shore conditions, should be chosen with care.

C. A. K.

PHYSIOLOGY.

Ocular Accommodation. — For several years past Dr. Theodor Beer,[1] of the University of Vienna, has been investigating ocular accommodation in those animals which possess well-developed camera eyes, and has presented in a lecture before the Fourth International Congress of Physiologists an admirable survey of this subject. According to him such water animals as the dibranchiate cephalopods and the bony fishes possess eyes which in the resting condition are accommodated for short distances, and which require active accommodation for vision at long distances. This is brought about by shifting the lens, without changing its curvature, from a distant position to one nearer the retina. In the cephalopods this shifting is accomplished by the contraction of a ring-shaped muscle which works against the deeper contents of the eyeball. In the bony fishes a band-like muscle, the retractor of the lens, draws that body inward toward the retina.

In the air-inhabiting vertebrates the resting eye is accommodated for distant vision. Near vision is possible only by active accommodation. This is accomplished in one of two ways: either the lens, unchanged in form, is moved away from the retina, as in amphibians and most snakes, or the convexity of the outer surface of the lens is increased, as in a few snakes, the turtles, crocodiles, lizards, birds, and mammals. The outward movement of the lens is brought about by an increase of pressure in the vitreous humor, produced by muscular contraction; the change in the convexity of the lens is induced by the well-known indirect action of the ciliary muscle.

In all the groups of animals examined, with the exception of the cephalopods and the birds, some species were found in which accommodation was entirely or almost entirely absent; such, for instance, was the case in the cartilaginous fishes, the sea eels, haddock, frogs, toads, salamanders, alligators, some lizards, vipers, and many rodents. Many of these are night animals, and possess in the daytime so small

[1] Beer, T. Die Accommodation des Auges in der Thierreihe, *Wiener klinischen Wochenschrift*, Nr. 42, Jahrgang 1898.

a pupil that the images on their retinas are formed by this opening rather than by the lens, which is thus in a measure functionless.

Most vertebrates are unable to accommodate their eyes so that they can see equally well in water and in air. Water animals when in the air are extremely shortsighted; air-inhabiting forms when in water are very farsighted. Only some few vertebrates, such as the pond turtles which seek their prey both by land and water, seem to see well on land and yet accommodate for near vision in water.

Those animals that accommodate by moving their lenses (cephalopods, fish, amphibia, and some snakes) presumably suffer no special loss of this power as age advances. Those whose accommodation depends upon a change in the form of the lens, brought about through its elasticity (most reptiles, birds, and mammals), probably suffer as the human being does, and become permanently farsighted as age advances. G. H. P.

The Sense of Hearing is the subject of a popular discourse delivered by Dr. K. Vohsen[1] before the Senckenberg Natural History Society and published in their proceedings. The speaker calls attention to the relation between speech and hearing, and shows in a table the zoölogical distribution of sound-producing and sound-perceiving organs. While almost all animals possess the latter, only arthropods and vertebrates possess the former. The auditory vesicles of the invertebrates, as well as the inner ears of the vertebrates, are described. Only a hint is given that the so-called auditory organs of the lower animals may also be concerned with the function of equilibration, and no mention is made of the fact that, in the cases most carefully examined, equilibrations seem to be the exclusive function of these parts. The lecture contains an excellent table showing the range of hearing in the human ear, and the complex question of the analysis of sound by the ear is considered. G. H. P.

Physiology for Schools. — In a little book of Laboratory Exercises[2] Mr. James Edward Peabody has done a good work, for which many teachers will be grateful. By series of skillfully framed questions upon objects readily accessible, the pupil is led to exert his

[1] Vohsen, K. Über den Gehörsinn, *Bericht d. Senckenberg. naturf. Gesell.*, 1898, pp. 91–112.

[2] Peabody, J. E., Instructor in Biology in the High School for Boys and Girls, New York City. *Laboratory Exercises in Anatomy and Physiology.* New York, Henry Holt & Co., 1898. Cloth, x + 78 pp., interleaved.

powers in making simple yet significant observations, experiments, and inferences which cannot fail to awaken a lively interest. Certain of these exercises are intended to be performed by the pupil at home and reported on in class. Others involve a demonstration by the teacher before the class. Not the least valuable feature is a series of questions to be used in making a "Comparative Study of the Mammalian Skeleton," as shown in such a collection as that of the American Museum of Natural History. This points the way to a wider educational use of museums in large cities. The book is full of helpful suggestions.

The only passages noticed as calling for amendment are the following: On p. 62 the pupil is directed to "prepare a strong solution of quinine in water by dissolving sulphate of quinine in water by the aid of sulphuric acid." This is hardly explicit enough for home use. Moreover, sulphuric acid in inexperienced hands seems unsafe. In the directions for applying "the nitric acid and ammonia test" (p. 22) the boiling necessary to secure the xantho-proteic reaction is not mentioned.

FREDERICK LEROY SARGENT.

Overton's Physiology.[1] — It is not often that we find so much nonsense compressed into a small volume as a casual glance reveals in this one. A few extracts will show the character of the whole volume. "In moist earth there lives a little animal called the *ameba*." "All animals must have water to drink." "*Oil*, or *fat*, is found in little pockets between the cells." "The fat around the cells is like a cushion, which protects the cells and keeps them warm." Starch grains "dissolve in water and form a paste." "When the plant ripens, the starch changes to sugar." "Most of the fat is oxidized in the lungs." The mind "tells the liver cells to change the digested food to blood." "The mind lives in a few cells and rules all the rest." "From the cells [of bone] there go out fine strings of connective tissue. Lime is mixed among the strings like starch among the fibers of a linen collar." Between the vertebræ "are thick, strong pads of tough flesh or gristle." The scapula "is not joined to any bone." "A muscle is large at one end and is fast to a bone." "The power of a muscle comes from the heat of oxidized food." "Cell, the smallest part of the body which can live when separated from the rest." "The only cells of the body which can move about are the white blood cells. The rest are held in place by strings of

[1] Overton, Frank, A.M., M.D. *Applied Physiology, including the Effects of Alcohol and Narcotics.* New York, American Book Company, 1898.

connective tissue." "The liver cells also change sugar into a kind of starch. This is soon oxidized in the liver, and heat is produced for the use of the body." And so on *ad nauseam*.

Animal Hypnotism.[1] — The first part of Professor Verworn's *Contributions to the Physiology of the Central Nervous System* is taken up with an interesting account of the so-called hypnotism of animals. As early as 1636 Schwenter described the well-known experiment in which a hen is held on a horizontal surface, and a chalk-line drawn from her head over the surface; on releasing her, instead of recovering her normal position, she may remain motionless for some considerable time. Ten years later Kircher described the same experiment, except that he directed that the hen should be bound with a cord and part of the cord stretched in place of the chalk-line. On drawing the chalk-line the cord could be removed, leaving the hen motionless. In 1872 Czermak showed that the cord and chalk-line were superfluous, and that the experiment succeeded perfectly well without them. He likewise called attention to similar phenomena in the crayfish. The next year Preyer published experiments of a like nature on the guinea pig and frog. These were followed by contributions from Heubel and from Danilewsky, both of whom worked chiefly with the frog. As a result of these studies it was found that many animals, chiefly vertebrates, when placed in abnormal positions and held there till their struggles to recover had ceased, would remain motionless in some cases for an hour or more, especially when they were protected against strong sensory stimuli.

Schwenter believed the animals remained still from fright, and this idea was elaborated by Preyer. Kircher thought that the hen, knowing she was bound, believed it useless to resist, and therefore lay still. After the removal of the cord she mistook the chalk-line for the cord, and, believing she was still bound, made no effort at recovery. Czermak, and later Danilewsky, regarded the condition as directly comparable with the hypnotic state of the human subject. Heubel sought for an explanation of the phenomenon in conditions parallel with sleep.

In dealing with this subject Verworn considers three questions: first, what is the pose of the body and the condition of the musculature when the animal is "hypnotized"? secondly, to what extent is

[1] Verworn, Max. *Beiträge zur Physiologie des Centralnervensystems.* Erster Theil. Die sogenannte Hypnose der Thiere. Jena, G. Fischer, 1898. iv + 92 pp., and 18 illustrations in the text.

it open to sensory stimulation? and, thirdly, what part of the central nervous system is essential to this state? Answers to these questions are obtained from observations on guinea pigs, hens, frogs, and asps.

The postures which the "hypnotized" animals assume represent usually some step in the process of recovering from their abnormal positions, and they are held in these positions by a tonic contraction of their muscles. They are, so to speak, like so many instantaneous photographs of animals, in process of righting themselves. Verworn believes that the reason they remain motionless in this condition is not because their motor impulses have been inhibited, but simply because there are no such impulses.

In the "hypnotic" condition the animals' senses are normally acute, but their reflex capabilities are probably actually reduced, though the loss of this power may in part be due to exhaustion.

Heubel found that the experiments made on the frog could be performed as well on an animal without its cerebral hemispheres as on one in normal condition. This important observation has been confirmed by Danilewsky and by Verworn, and the latter has demonstrated the same to be true for the hen. In the hen, however, the presence or absence of the cerebrum makes a difference. While in both cases the animals may be brought into a motionless condition, a hen without a cerebrum will remain motionless an hour or more, instead of ten minutes, as in the normal animal. Moreover, her recovery is always associated with some obvious sensory stimulation, which is not necessarily so in the case of the normal hen. Guinea pigs whose spinal cords have been cut respond to the assumed hypnotic influence only by the anterior portions of their bodies. From these experiments Verworn concludes that the center for readjusting the position of the body, as well as that for the tonic contraction of the muscles, cannot lie in either cerebrum or cord, but must be somewhere between these parts. He assumes with reason that it is located in the cerebellum. It is remarkable, however, that Verworn has not attempted to test this assumption by trying experiments on animals from which the cerebellum had been removed.

According to Verworn the motionless condition of the animals is dependent upon two factors — a tonic stimulation of the cerebellar reflex center, whereby the animal is held in an attitude of recovery, and an inhibition of the motor areas of the cerebrum. As the cerebrum acts only in this negative way, an animal without its cerebrum may be made motionless by the positive action of its cerebellar cen-

ter. In recovery the animal without its cerebrum is dependent upon its sense organs to generate impulses which may eventually affect its cerebellum, while the normal animal may have its cerebellum influenced not only through its sense organs, but also from its centers for spontaneous movements in the cerebrum. Thus animals with a cerebrum usually recover sooner than those deprived of this organ. The motionless condition in animals has then only a superficial resemblance to certain phases of hypnotism as seen in the human subject, and probably is an essentially different phenomenon.

G. H. P.

ZOÖLOGY.

Generic Names Preoccupied. — Dr. Carlos Berg has done a useful work in a critical study of recently proposed generic names with a view to the elimination of those preoccupied. In *Communicaciones del Museo Nacional de Buenos Aires*, 1898, pp. 41, 43 (December 17), he proposes to substitute the following names of animals for others preoccupied. Hoferellus for Hoferia; Iheringiana for Iheringiella; Halochnaura for Asterope; Gestroana for Gestroa; Corynophora for Halterophora; Meyrickella for Prionophora; Walsinghamiella for Gilbertia (Lepidoptera); Watsoniella for Watsonia; Schochidia for Lophostoma; Braunsianus for Anelpistus; Gilbertidia for Gilbertina; Matæocephalus for Cœlocephalus. The last two are genera of American fishes.

D. S. J.

Deep-Sea Fishes of Iceland. — Dr. Christian Lütken has just published, in English, a most valuable account of the fishes dredged by the "Ingolf" in 1895 and 1896 off Iceland and the Faroë. Forty-four species are recorded, three of them new, *Raja ingolfiana*, *Cyclothone megalops*, and *Macrurus ingolfi*. Important notes are given on the structure of different species. The lithographic plates of Cordts (some of them colored) which illustrate this paper are most excellent.

D. S. J.

Spolia Atlantica. — Dr. Christian Lütken, of the University of Copenhagen, has continued his most valuable discussion of the early stages of development of fishes, as shown by the rich "spoils of the Atlantic," young fishes taken in the open sea. The third paper of

this series, just published by Dr. Japetus Steenstrup and Dr. Lütken, treats of the development and structure of the "Molidæ, or Head-fishes," called by them "Klumpfish," or "Moon-fish," the family constituting the two genera Mola and Ranzania.

The changes which take place in the growth of these fishes are most remarkable, and have led to the establishment of very many (thirteen) nominal genera, besides the two which have a real basis in adult structure. The most persistent of these genera was the diminutive Molacanthus, a stage of growth which was naturally and apparently logically taken for an adult fish.

This paper, like all of Dr. Lütken's, is very conscientiously written and admirably illustrated.

We miss, however, the usual "Résumé en français," an important help to those whose knowledge of Danish is casual and incomplete.

D. S. J.

Fishes of New South Wales. — The government of New South Wales has lately published a review of trawling operations of H. M. S. "Thetis," conducted along its coast by Frank Farnell.

The record, valuable for economic purposes, is supplemented by a "Scientific Report" on the fishes by Edgar L. Waite. In this report numerous species are enumerated, two of them new to science, with fairly drawn figures by Mr. Waite.

The nomenclature is very antiquated, the author apparently depending almost entirely on *Günther's Catalogue of the Fishes of the British Museum*, the one published volume of Boulenger's masterly catalogue being ignored. There is reason to doubt the accuracy of certain identifications. The new species are as follows: *Histiopterus farnelli*, *Chimæra ogilbyi*; but doubtless others will appear when the material has been more critically studied.

D. S. J.

Fresh-Water Ostracoda of South America. — The fresh-water collections made at Montevideo, in the Straits region, and in Chili by the Hamburg Expedition, have been examined for Ostracoda by Dr. W. Vavra[1] of the Prag Museum. He finds but eight species, three of them being well-known cosmopolites, while the remaining five are described as new. The list of Ostracoda known from South America is thereby increased to twenty-six. One species is added to the subgenus Chlamydotheca, a group characteristic of the southern

[1] Vavra, W. Süsswasser-Ostracoden, *Hamburg. Magalhaensische Sammelreise.* 26 pp., 5 Abb. Hamburg, 1898.

hemisphere. Species of this genus have been reported from Ceylon and South Australia, from Patagonia, the Falkland Islands, Argentina, Brazil, Venezuela, and from Vera Cruz, Mexico. A single species only has been found in the temperate regions of the northern hemisphere, having been described by Turner in 1892 from Cincinnati as *Cypris herricki.* Dr. Vavra now regards this as identical with *C. speciosa* Dana, described in 1838 from Rio de Janeiro. The genus Notodromas also receives an addition from South America in *N. patagonica.* Two of the three species of this genus previously known belong to the South Australian region, and one is cosmopolitan in its distribution. Dr. Vavra's paper thus affords further data for the oft-recurring discussion of the similarity of the southern fauna of the eastern and western hemisphere.

C. A. K.

New Flagellata from the Rhine.[1] — Eight new forms are described by Dr. Lauterborn from the Rhine and its adjacent waters. Of especial interest is his *Bicosœca socialis*, a free-swimming colony in which each zooid exhibits a well-defined but rudimentary collar about the single flagellum, a condition which suggests a possible origin for the Choanoflagellata. A colonial Chrysomonad, *Hyalobryon ramosum*, is sessile, differing in this respect from the closely allied Dinobryon, which is pelagic in habit. Hyalobryon is also peculiar in the method of attachment of the superposed loricæ, these being fastened by their basal tips to the outside of the supporting lorica. Lauterborn suggests the possibility that this form may be identical with *Epipyxis socialis*, described by Dr. A. C. Stokes[2] from New Jersey. The absence in this latter description of any reference to the method of attachment of the loricæ and to the characteristic growth rings on their distal ends seemed to justify the establishment of a new genus for the species from the Rhine. A new pelagic colonial form, *Chrysosphærella longispina*, resembles *Synura uvella* in the form of the colony and in the structure of the individual zooids, but differs from the latter in the fact that each zooid bears but a single flagellum, and in addition a pair of long silicious tubes which project considerably beyond the colony. They rise from pedestals shaped like wine-glasses, and resemble somewhat the spines of the heliozoan Acanthocystis. As floats they may assist in the pelagic habit.

C. A. K.

[1] Lauterborn, R. Protozoën-Studien. IV. Theil. Flagellata aus dem Gebiete des Oberrheins. *Habilitationsschrift Univ. Heidelberg.* 37 pp., 2 Taf. Ludwigshafen am Rhein. 1898.

[2] *Proc. Amer. Phil. Soc.*, vol. xxvii (1890), p. 76.

Pond Infusoria.[1] — The activity of the Bohemian fresh-water biological station is manifested by Švec's paper on the Infusoria of the Unterpočernitzer pond. Workers in fresh-water fauna will welcome the very full biological and systematic treatment of an hitherto much neglected field of investigation. Pelagic Infusoria are represented by but seven species, three of which are described as new. *Codonella lacustris* alone occurs throughout the year, being found under the ice in the winter and reaching a maximum in the spring. The lowering of the temperature of the pond during the summer by an influx of rain water is followed by a rapid increase in the number of this species. Littoral Infusoria abound, not only among the aquatic vegetation and the diatoms alongshore, but also in the surface scum which gathers in such regions. The greater part of the sixty-nine species recorded in the paper occur in this region. The bottom fauna contains but few individuals belonging to but six species. In all, ten new species are described.

C. A. K.

Variation in Veneridæ.[2] — The result of work on 1000 specimens of a Western representative of the large Veneridæ from many localities is another illustration of the extreme variation, not only in color tint but in color scale and color pattern, which may exist in an otherwise very well demarcated form. Sixteen varieties based on color are described and arranged in six groups. These varieties are not traced to their relations with environment, though all forms, except those based on the number of rays, are said to be highly local. The varieties would appear to be discontinuous; *e.g.*, Mr. Stearns appears to indicate that the number of rays is either just about the typical twenty or "very many" more or "very many" less. It is interesting to note that the two valves vary independently of each other. In fact, it would seem from Mr. Stearns's description that one valve might be *Cytherea crassatelloides var. pauciradiata*, while the other was *C. crass. var. multiradiata*. With this extreme variation in color goes extreme stability of form and interior coloration. The only variety of form noted is in degree of ventricosity and elongation, clearly correlated with an exposed habitat calling for deeper burrowing and consequent elongation of siphons.

[1] Švec, F. Beiträge zur Kenntniss der Infusorien Böhmens. I. Die ciliaten Infusorien des Unterpočernitzer Teiches, *Bull. Int. Acad. d. Sci. Bohême* (1897), pp. 1–19, Tab. I, II.

[2] Stearns, R. E. C. Notes on Cytherea (Tivela) crassatelloides Conrad, with Descriptions of Many Varieties, *Proc. U. S. Nat. Museum*, vol. xxi (1898), pp. 371–378, Pls. XXIII–XXV.

We think the main value of the work is its illustration of the worthlessness of exterior coloration in shells to the systematist, and the interest of this ornamentation problem as an independent question of physiology, or possibly of morphology.

F. N. BALCH.

Distribution and Variation. — In the *Procès Verbaux Soc. Roy. Malacol. de Belgique* meeting of February, 1898, is reported an interesting discussion on "L'Émigration considérée comme facteur de l'évolution et de filiation des espèces." It was *apropos* of a paper by M. Arnold Locard in the *Compt. Rend. l'Acad. Sci.*, No. 5, 1898, on the area of distribution of the molluscan fauna of the boreal Atlantic in the deeper waters to the south. Locard pointed out that recent explorations had shown that forms littoral or sublittoral in the boreal regions have spread southward, into ever-deepening waters, from an area approximately of common origin, down the European and African shores to the latitude of Guinea, in about 2000 fathoms, and down the American shores to the latitude of the Antilles, in about 800 fathoms. The area of distribution would thus have the form of a vast triangle of which the apex would rest in about 50 fathoms, somewhere north of Iceland, while the base connected the north-tropical shores of Africa and America, passing upward from east to west from a depth of 2000 fathoms to one of 800. M. Locard's idea, M. Van den Broek thought, was that migration occurs, speaking largely, in opposition to variation. That is, a northern species under pressure from a changing environment or from crowding might spread along the coast where bathymetric and other conditions would be little changed, but the temperature change would be great, or it might spread downward where the changes would be just the opposite. In either case it would follow the line of least resistance; *i.e.*, that in which the required variation would be least. Emigration would replace adaptation and prove a factor of stability.

From this idea M. Van den Broek differs. He points out that while deeper water was doubtless the line of least resistance in migration, and probably called for less variation than migration along the coast would have done (as is indicated, moreover, by the archaic facies of abyssal life), yet the *cause* of migration is uncertain. It may be to escape the competition of more competent rivals, or local enemies, or parasites, or it may be in the wake of a migrating food supply, and in such cases might not be along the line calling for least variation. In the case of the deep-water and arctic Mollusca it

certainly appears that temperature was the main factor, and probably it was true that changes in bathymetric conditions called for less variation than changes of temperature conditions would have done; but, even so, migration proves ultimately a great source of variation. The gradual nature of changes on the sea-bottom leads to very extended distribution, and consequently into areas which are changing in very opposite ways; *e.g.*, sinking and rising. With such wide geographical distribution come extreme differences, eventually, in food and other variation factors. Oscillation of the bottom, M. Van den Broek thinks, would be particularly effective in breaking up the widely dispersed species, and he points out that a species changed by a shoaling of the water would not revert to its old form upon the waters again deepening, but would undergo a second change, removing it yet a step from the ancestral form which lived under similar conditions. M. Van den Broek believes widespread movements like the one under discussion have taken place repeatedly, and that the ancestors of a given fauna are to be looked for, not in the underlying strata, but in distant formations representing the same essentials of environment. Thus he finds the ancestral forms of the Belgian Miocene sands, not in the underlying Oligocene clays, but in the older Miocene of North Germany, while the descendants of the Belgian Miocene sands he identifies, tracing a northeast to southwest migration, accompanied by an increasing salinity and depth, but constant temperature, in the fauna of the Coralline Crag of Suffolk; while above this point, in the Red Crag, he sees the extinction or profound modification of the forms and an invasion of new boreal forms, indicating a great increase of depth by sinking.

This discussion is suggestive, but it seems clear that M. Van den Broek has not settled the question. If his species migrated into deep water because it was the line of least resistance in the first place, why did they not do so again when the bottom rose? Again, is it not true that no matter what the cause of migration may be, that method is chosen because it is the one calling for least modification? We will suppose that a migration along the shore calls for greater modification than migration into deeper water, and that the original habitat is unchanging, but that competition is too great or depredation too fierce. It seems that the greatest amount of modification would be needed before the competition would be successfully met or the depredation resisted. If less were required for this than for the change of habitat, the difficulty would be thus met.

The consideration of migration as a factor of stability is of some

interest, and certainly the deep-sea fauna is an excellent subject for such speculations, because, as Mr. Dall has so interestingly pointed out, the struggle for life on the sea-bottom must in great depths be reduced to a minimum, from the vast area at the disposal of any species, the practically unlimited supply of food, such as it is, the fewness of predatory forms, and the rarity of the sudden vicissitudes of land and littoral life; so that such modifications as do take place must be comparatively direct results of the physical environment.

F. N. BALCH.

Zoölogical Results of Dr. Willey's Expedition. Part II.[1] — The second part of the zoölogical results of Dr. Willey's expedition to the Western Pacific comprises reports on the genus Millepora by Dr. Sydney J. Hickson, Echinoderms by F. Jeffrey Bell, Holothurians by F. P. Bedford, Sipunculoidæ by A. E. Shipley, Solitary Corals and Postembryonic Development of Cycloseris by J. Stanley Gardiner, Earthworms by F. E. Beddard, and Gorgonacea by Isa L. Hiles.

Dr. Hickson ascribes all of the specimens of Millepora to *M. alicornis*, which, he has before pointed out, is the only species of Millepora so far known. The parts of Dr. Hickson's paper that are particularly interesting are those that are devoted to the parasites of this coral. In addition to worms and algæ, he speaks of "spots scattered over the surface of the coral having the general appearance of a rash." He concludes "that these bodies are clusters or zoöglœæ of parasitic bacteria." Of the thirty-nine species of Echinoderms of Professor Bell's Report, two of which are possibly new, six belong to the Crinoids, twelve to the Echinoids, fourteen to the Asteroids, and seven to the Ophiurioids. Two new species of Holothurians are described by Mr. Bedford among the twenty-four in the collection. Mr. Bedford calls attention to some interesting variations in two species, in the number of stone canals, polian vesicles, and cuverian organs. Mr. Shipley's account of the Sipunculoidea enumerates twenty-three species, none of which are new. Probably the most important contributions to systematic zoölogy in the series are the papers of Mr. Gardiner and Miss Hiles, and Mr. Beddard's report on the earthworms. Mr. Gardiner describes eleven new species of solitary corals among fourteen, and Miss Hiles four new forms of

[1] Willey, Arthur, D.Sc., etc. *Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands, and Elsewhere*, collected during the years 1895, 1896, and 1897. Part II. Cambridge, the University Press (1899), pp. 121–206, Pls. XII–XXIII.

Gorgonacea in ten. Three of the nine earthworms in Mr. Beddard's account are new. The photogravure illustrating Mr. Gardiner's paper is one of the best we have seen in the application of photography to zoölogical illustration.

A striking feature in this second part of the results of Dr. Willey's expedition is, that of the 127 species embraced in the different reports only eighteen are new, and about 90 per cent of these are Anthozoa from comparatively deep water. This is explained by the fact that Dr. Willey was the first to undertake systematic dredging in the Western Pacific. For the high character of the typography and mechanical execution of the book, it is only necessary to say that it bears the imprint of the University Press.

The Distribution of the Perissodactyla, Lamnungia, and Artiodactyla. — Carl Grevé[1] has published a new number of his series of zoögeographical monographs, treating of the distribution of the Perissodactyla (horses, rhinoceroses, tapirs), Lamnungia (Hyrax), and Artiodactyla *non ruminantia* (Hippopotamus, Sus, and their allies). In its general plan this part follows closely the former publications of the same author,[2] and gives a very elaborate report on the distribution of the groups named in the title.

The chief value of this memoir consists in the detailed account of the single localities from which each species has been recorded, and in the summing up of the results for the species, genera, and families in tabular form, accompanied by colored distributional maps for the genera and species. Thus the author has fixed the actual distribution of each species, and his work will always be of much use to any subsequent writer, for it gives the facts of geographical distribution pure and simple.

Evidently the author did not intend to give anything else than facts. However, zoögeography is not satisfied with the mere establishment of facts, but wants explanations; and these identical groups have been the subject of discussion before. We know that in former times, during the Tertiary period, the distribution of every single one of the above groups of mammals was very different from the present, and on the other hand we know that in many cases these old conditions may explain the present ones. Mr. Carl Grevé does not try to enter into any details in this respect; indeed, he gives on the head of each group a general review of our knowledge of its paleontology,

[1] *Abhandl. Kais. Leop.-Carol. Akad. Naturf.*, Bd. lxx, Nr. 5, 1898.

[2] Carnivora and Pinnipedia, *ibid.*, Bd. lxiii, p. 1, and Bd. lxvi, p. 4.

but it would have been much better to leave that aside entirely; for the reader, noticing these discrepancies between recent and fossil forms, is not satisfied with the simple fact that things have changed since Tertiary times; and, farther, these paleontological introductions to each chapter cannot claim at all to be reliable; indeed, they appear to have been written without the slightest knowledge of Tertiary — especially American — Mammalian Paleontology.

A. E. O.

Recent Papers on Sipunculids. — In the collections brought from South Africa by Professor M. Weber, Sluiter[1] finds four species and one variety, all known forms of Sipunculids, and one species of Thalassema, making a total of only twelve species and two varieties of these groups reported from the east coast of Africa. He explains the poverty of this fauna as due to the lack of extensive coral reefs, which are its fittest habitat. An appendix to the report deals with the form previously described by Sluiter as *Sipunculus indicus* Peters, which Fischer surmised was not the true *S. indicus*. Sluiter now proposes the name *S. discrepans* for the species, and gives an extended description of the differences between the two. Of especial interest is the dissimilarity in the structure of the skin, which appears to offer one of the readiest means of specific determination in this genus.

In contrast with the poverty of the African coast, Shipley[2] reports a collection made in Rotuma and Funafuti containing fourteen species, of which two, *Sipunculus rotumanus* and *S. funafuti*, are new; one, *Physcosoma varians* Kef., has not yet been reported outside of the Atlantic, where it is common; and one, *Thalassema vegrande* Lamp., has been found but once before, in the Philippines. The other forms noted are common to various localities in the Pacific and Indian Oceans and Red Sea.

The description by the same author of the forms collected by Dr. Willey[3] further shows the richness of this group among the Pacific islands. All the twenty-three species obtained are known forms belonging to Sipunculid genera, as follows: Sipunculus eight species, Physcosoma seven, Aspidosiphon five, and Cloeosiphon, Phascolion, and Phascolosoma one species each; of these, six are identical with species reported in the preceding paper. The author emphasizes

[1] Gephyreen von Süd-Afrika, nebst Bemerkungen über Sipunculus indicus Peters, *Zool. Jahrbücher*, Abt. f. Syst., vol. xi, pp. 442–450, 2 figs.

[2] Report on the Gephyrean Worms collected by Mr. J. Stanley Gardiner at Rotuma and Funafuti, *Proc. Zoöl. Soc.*, London, 1898, pp. 468–473, Pl. XXXVII.

[3] A Report on the Sipunculoidea collected by Dr. Willey at the Loyalty Islands and in New Britain, *Zool. Results*, Pt. ii, pp. 151–160, Pl. XVIII.

the extreme variability of the Sipunculids in external appearance, and the difficulty of specific determination. In *Sipunculus australis* the so-called hooks on the introvert were found to be actually only thickened cuticular ridges, elevated like rolls above the surface; and though characteristic, these structures do not warrant the statement of various authors as to the occasional presence of hooks in this genus. While the large collections of Sipunculids made by Semper, Sluiter, and others, in the Philippine and Malay archipelagoes, have yielded a knowledge of the group in these regions superior to that from other tropical seas, still Shipley is inclined to look upon the Malay archipelago as the center for this group, from which it has spread east along southern Asia to the Red Sea, and outward over the Pacific and Indian Oceans. The abundance, particularly of certain species, in this territory is to be associated with the prevalence of coral reefs over the area.

H. B. W.

The Palolo Worm. — The long-existing ignorance concerning this interesting annelid that comes to the surface of the ocean during the third quarter of the moon in October and November, in the Samoan and Fiji islands, has recently been somewhat diminished by the independent researches of Friedländer[1] and of Krämer.[2]

We seem now pretty certain that the creature comes from shallow water — not from mysterious depths; that it lives in dead coral masses; that it casts off the main part of the body to swim free and discharge eggs and sperm when ripe, while the head end probably remains in the coral to regenerate. The suggestion that it is the combined warmth of the sun with least tides that brings on this maturity at a particular phase of the moon seems in the right direction; still we remain ignorant of the real cause of this exact periodicity in reproduction. We are not absolutely sure of the genus to which the creature belongs — despite the fact that so many Europeans have noted its appearance, and that it occurs so abundantly that the natives make its capture for food a set feast, and have incorporated its habits in their folk-lore.

E. A. A.

Is Fertilization a Process of Feeding? — N. Iwanzow[3] describes remarkable pseudopodia and tufts of filous threads sent out by *miniature* eggs of a helothurian to seize and engulf spermatozoa. In two

[1] *Biolog. Centralblatt.*, vol. xviii, May, 1898.
[2] *Ibid.*, vol. xix, January, 1899.
[3] *Bul. Soc. Imp. Nat. de Moscou*, Nr. 3, 1897.

hours a large number of sperms are thus slowly ingested, and the egg will take no more till the following day, when a second feeding may occur if sperm is offered; even a third was once accomplished when the eggs were kept alive long enough.

From preserved eggs the author gathers that the ingested sperms pass slowly through the egg *into the nucleus*, and are there resolved into granules distributed along the nuclear network.

The inference is drawn that normal maturation, the formation of polar bodies, by removing nuclear matter, lessens the digestive power of the egg, so that it takes in but one sperm and does not digest it! The chematropism of egg and sperm is but a form of that of animal for food. We are even asked to follow the idea that all psychic processes are but expressions and consequences of nutritional processes. E. A. A.

Zoölogical Notes. — R. Collett (*Bergens Museums Aarborg* for 1897) gives an interesting account of the present and past distribution and of the habits of the beaver in Norway. A summary in English and numerous photographs of beaver lodges, nests, and young make the results accessible to the general reader. Owing to the protection furnished by the game laws, these animals increased in number from 60 in 1880 to 100 in 1883, and have since held their own, or perhaps gained.

In the last number of the *Archives de Parasitologie*, Blanchard presents a valuable and interesting summary of the cases of pseudoparasitism in man on the part of various Myriapods. All of the 35 authentic cases, among them 6 entirely new, are reported in full. In 27 cases the animal was located in the nasal fossæ or their connecting cavities, while in 8 cases it came from the alimentary canal. In about half the instances the species was accurately determined.

G. Schwalbe (*Morph. Arbeiten*, Bd. VIII, Heft 2, p. 341, 1898) gives an account of his studies on the supposed open rudimentary marsupial pouches of certain ungulates. His attention was directed to the embryos of the sheep and a species of antelope. He concludes that these pockets, which are quite well developed in sheep embryos, are in no sense homologous with the true marsupium, but that they have a very different origin.

The Graeffe-Saemisch Handbook is announced in a revised edition by Engelmann under the editorship of Professor Saemisch of Bonn. The first part of the new work is to consist of three volumes on the

anatomy and physiology of the eye; the second part, of nine volumes on the pathology and therapeutics of this organ. The large number and high standing of the collaborators give promise of a speedy and satisfactory performance of the work. Volumes, or parts of volumes, will be sold separately.

The rich collection of cetacean embryos made some years ago by Professor Kükenthal is being put to good use, as shown by the last number of *Jenaische Zeitschrift* (Bd. XXXII, Heft 1 and 2), which is made up of the following articles based on a study of this material: F. Jungklaus, The Stomach of the Cetaceans; O. Müller, Researches on the Alterations which the Mammalian Respiratory Organs have undergone in Adaptation to Water Life; W. Daudt, Contributions to our Knowledge of the Urogenital Apparatus of the Cetaceans.

In the *Festschrift til Kong Oskar II*, Dr. Guldberg publishes the results of his investigation on the asymmetry of the higher vertebrates. Osteometric statistics, as well as data from the weight of the musculature of opposite sides of the body, indicate the occurrence of a morphological asymmetry in birds, in many mammals, and in man. This asymmetry is least at birth and increases with age; it finds its physiological expression in the tendency to move in a circle. Compensated and crossed asymmetry are of frequent occurrence.

The Organs of Respiration of the Oniscidæ are described by Professor J. H. Stoller in *Zoologica*. He finds the gills to be homologous with those of aquatic isopods, but adapted to breathing atmospheric air. A respiratory tree, resembling the tracheæ of insects, is bathed by the blood which is brought to the gills. Adaptations for the prevention of the desiccation of the blood are found, and there is no mechanism for forcible inspiration and expiration of the air.

The Parasites of the Flamingo have recently been studied in Tunis by Dr. M. Lühe (*Situngsb. Pr. Akad. Wiss.*, Vol. XL, pp. 619–628), who has found *Tænia lamelligera* Owen, which Diamare made the type of a new genus, Amabilia. Three species of Drepanodotænia were also found: *Tænia liguloides* Gerv., and its immature form, which proved to be identical with *T. Caroli* Par., and *T. megalorchis* and *T. ischnorhynchan.* sp. In the same host *Monostoma attenuatum* Rud. was present in the cæcum, and the new species *Distomum michropharyngeum* in the gall bladder, and *Echinostomum thœnicopteri* in the small intestine. From the civet-cat two new forms of Dipylidium, *D. triseriale* and *D. monoophorum*, were secured.

The specimens of Mermis in the Kgl. Museum für Naturkunde in Berlin have recently been studied by von Linstow (*Arch. mikr. Anat.*, Vol. LIII, pp. 149–168), who gives an extended taxonomic account of the genus, followed by a discussion of anatomical and histological features. In the last three lines of the paper and all too easily overlooked comes the establishment of a new genus for those species, *M. crassa* and *M. aquatilis*, which are characterized by the possession of only a single spicule.

Dr. Saint-Remy has added a complement to his valuable synopsis of the monogenetic Trematods (*Arch. Parasitol.*, Vol. I, No. 4, pp. 521–571). The present paper is a revision of the synopsis, including all new matter since 1891, and is a most welcome contribution to our knowledge of this important group of parasitic worms. Forty-nine species have been added and a new key prepared.

Indo-Malayan Landplanarians are brought together in a synoptical table or key for easy determination by von Graff (*Ann. Jardin Bot. Buitenzorg*, Supp. II, pp. 113–127). About 35 per cent of all known species are found in this region.

Dr. N. A. Cobb has added another to his series of studies on the free-living Nematoda (*Proc. Linn. Soc. N. S. W.*, Vol. XXIII, No. 91, pp. 383–407), adding seventeen new species to the worm fauna of Australia. All of the forms are from Port Jackson.

The Leeches of the U. S. National Museum have been studied by J. Percy Moore (*Proc. U. S. Nat. Mus.*, Vol. XXI, pp. 545–563), and of the small national collection, consisting of species from all parts, six are described as new.

Hypodermic Impregnation has been observed by Dr. E. G. Gardiner in the acoelous turbellarian *Polychœrus caudatus* (*Journ. Morph.*, Vol. XV, No. 1), thus adding another to the list of forms in which impregnation of this sort occurs.

The Earthworms of Japan are being studied by S. Goto and S. Hatai, the first of a series of papers being devoted to seventeen species of Perichæta (*Annot. Zool. Japon.*, Vol. II, No. 3).

Dr. R. S. Bergh in *Fauna Chilensis* reports upon the opisthobranchiate mollusca collected by Dr. Plate on the western coast of South America. A number of forms described fifty years ago by D'Orbigny from this locality are again brought to light, together with twelve new species.

Poisonous serpents are said not to exist in New Caledonia, contrary to the statement of Hoffmann in Bronn's *Thierreich.* Dr. Trouessart (*Bull. Soc. Zool. France,* Vol. XXIII, No. 11) believes that *Neelaps caledonicus* was derived by Hoffmann by misreading Günther's *Neelaps calonatus* from New Grenada.

The Zoantharia of the Magellanic Region have been reported on by Dr. O. Carlgren, and published by Friederichsen & Co. of Hamburg under the general title of *Hamburger Magelhaensische Sammelreise.* Thirteen new species and three new genera are described.

A new enemy to the grasshoppers, which for several years have been devasting Argentina, has developed in the shape of a scarabrid beetle belonging to the genus Frox, which has taken to eating the eggs.

Albinism in a squirrel is illustrated by photographs in *Bull. Soc. Zool. France,* Vol. XXIII, No. 11, by L. Petit, in the case of a brown squirrel which is about 50 per cent albino and nearly evenly marked.

Mr. W. S. Calman has published an exhaustive review of the literature on the reproduction of the Rotifera in *Natural Science.*

BOTANY.

Vines's Text-Book.[1] — In scope and bulk intermediate between Professor Vines's *Students' Text-Book of Botany* and the English edition of Prantl's *Elementary Text-Book,* this volume treats of the morphology, anatomy, physiology, and classification of plants in a clear and understandable way, and the illustrations, many of which are familiar to users of text-books, are in the main well selected.

T.

The Teacher's Leaflets, chiefly on nature-study, issued by the Agricultural Experiment Station of Cornell University, are admirably plain and direct presentations of everyday phenomena, the understanding of which is obscured by many of the more learned treatises. How a squash plant gets out of the seed, How a candle burns, Four apple twigs, How the trees look in winter, A children's garden, Some tent-makers, What is nature-study? Hint on making collec-

[1] Vines, S. H. *An Elementary Text-Book of Botany.* London, Swan Sonnenschein & Co. New York, The Macmillan Company. 611 pp., 397 ff. Price $2.25.

tions of insects, The leaves and acorns of our common oaks, The life history of the toad (with a unique tail-piece), and The birds and I, are the titles of some of the leaflets. T.

Elementary Science Bulletins of the Michigan Experiment Station, of which six have thus far been issued, dealing with Beans and peas before and after sprouting, Wheat and buckwheat before and after sprouting, Timothy and red clover before and after sprouting, Leaves of clovers at different times of day, Branches of sugar maple and beech as seen in winter, and Potatoes, rutabagas, and onions, are comparable with the *Teacher's Leaflets* of the Cornell Station. All of the series yet issued are by Professor Beal. T.

Water-Lenticels. — In a recent number of the *Forstlich Naturwissenschaftliche Zeitschrift*, Tubeuf discusses the formation of water-lenticels and their significance. After a brief statement of some previous views as to the occurrence and function of ærenchyma tissue, he puts the following questions:

1. Is the development of water-lenticels due to the irritant influence of the liquid water surrounding the stem, and is their development above the water due to a transmitted stimulus?
2. Is their development due to lack of oxygen?
3. Is their development an ecological adaptation of woody plants living in moist localities, or is their occurrence a general one?

He concludes that their occurrence is not a peculiarity of plants in moist soils, but is a general attribute of woody stems. Furthermore, the lenticels formed whenever there was moisture; in other words, *liquid* water was not necessary, hence there is no such thing as transmitted stimulus.

He comes to no definite conclusion as to the relation between lack of oxygen and profuse formation of water-lenticels, but is inclined to regard the water as the potent factor. A number of figures accompany the paper, showing water-lenticels of Sambucus, Ulmus, and Caragana. It may be mentioned that water-lenticels and ærenchyma on branches of Sambucus and other woody plants were described and figured by von Schrenk in *Trans. Am. Micr. Soc.*, Vol. VII (1896), p. 98, Pls. I–III. T.

Root-Tubercles of Alder. — The tubercles found on the roots of the alder and genera of the Eleagnaceæ were attributed by their discoverer, Woronin, to a fungus which he called *Schinzia alni*, and which

Brunchorst recently renamed *Frankia subtilis*. Frank regarded the peculiar cells always found in these tubercles as bodies of fungus origin, which had degenerated because of their mode of life within the cells of another plant. Moeller, on the other hand, regarded them as single-celled Hyphomycetes. From an extended series of experiments Hiltner[1] comes to the conclusion that *Frankia subtilis* is not a single-celled Hyphomycete, but a bacterial organism which possesses sporangia, and because of these and other peculiarities forms a connecting link between the bacteria and the true fungi. He succeeded in inoculating the organisms into roots of alder seedlings grown in N.-free nutritive solutions. The organisms enter through the root hairs in a manner similar to that of the organism causing leguminous tubercles. Inside of each hair is a mucilaginous thread in which the bacteria lie imbedded without any system or regularity. Before reaching the root proper the mucilaginous mass becomes filamentous and resembles mycelial threads. Within the root the mucilage masses resemble plasmodia, which extend from cell to cell, and ultimately become of a spongy consistency because of the appearance of numerous vacuoles, surrounded by thin walls of mucilage, in which the bacteria, now more or less in thread form, lie. Very soon after the formation of a tubercle the individual bacteria change into spheres filled with albumen, which rapidly differentiates into spores; in other words, the spheres represent sporangia. The spores germinate rapidly, forming short rods which fill the cells of the tubercle but develop no mucilage. Hiltner points out that, with the exception of *Bacillus erythrosporus*, few bacteria form sporangia. According to his view, the bacteroids of the leguminous tubercles must be regarded as sporangia, and in that case the bacteria of the alder and Leguminosæ, both forming plasmodia, constitute a new group of bacteria.

Numerous experiments have proven the fact that the organisms in the alder tubercles are capable of fixing atmospheric nitrogen; and, unlike those of the Leguminosæ, they are able to function fully under water. We are promised a full exposition of the subject in another journal at no distant date.

HERMANN VON SCHRENK.

The Red and Blue Coloring Matters of Flowers are discussed in *Natural Science* for February, by P. Q. Keegan, in continuation of a paper published in the same journal of December last. In view of

[1] Hiltner, L. On the Origin and Physiological Significance of Root-Tubercles. *B.* The Root-Tubercles of the Alders and Eleagnaceæ, *Forstlich Naturwissensch. Zeitschr.*, Bd. vii, p. 415, 1898.

the recent report of a blue carnation and the long horticultural search for a blue rose, it may be of interest to quote Dr. Keegan's conclusions: "1. A blue flower is unproducible in species which contain or are capable of forming phlobaphenic tannin [*i.e.*, chromogen, which on advanced oxidation evolves brown-red or muddy anhydrides more than sufficient to neutralize and overcome any tendency to blue coloration incident to the presence of gallic acid], no matter what the development of the inflorescence may amount to. 2. A blue flower is more likely to be produced in a species having a gamopetalous corolla or perianth, and therefore liable to evolve by higher oxidation a certain quantity of a high oxybenzoic acid. 3. In species wherein the tannin natural to the organism is iron-greening and non-phlobaphenic, a blue flower may possibly be producible in a polypetalous corolla, provided always that the petals or perianth be large relatively to the height of the plant and to the size and robustness of its stem and leaves; in this case it is uncertain whether gallic acid is necessary for the production of the effect, but any way an alkaline compound of an oxybenzoic acid would seem to be indispensable."

Botanical Notes.—Captain J. Donnell Smith, whose work on Central American botany is well and favorably known, publishes an enumeration of the plants collected in Central America by Dr. W. C. Shannon, as an appendix to Vol. I, Part II, of the report of surveys and explorations made from 1891 to 1893 by the Intercontinental Railway Commission. The "separates" of the article bear the imprint Washington, 1898.

Professor Peck's report of the state botanist, reprinted from the 51st annual report of the New York state museum, as is usual with his reports, contains descriptions and figures of a considerable number of fungi, several of which are believed to be new to science. It is unfortunate that, while the text is in octavo, the plates are of quarto size and separately bound.

At Bologna is preserved, in book form, the herbarium of Aldrovandi, dating from the middle of the sixteenth century. In *Malpighia*, Vol. XII, Fasc. 7–10, Professor Mattirolo, now of Florence, but until recently stationed at the University of Bologna, gives an annotated catalogue of the plants represented in the first volume of this herbarium, his list reaching 557 numbers.

Acalypha hispida, a New Guinea plant which, under the name of *A. sanderi*, is attracting a good deal of attention in horticultural

circles, is well figured in the *Botanical Magazine* for January. Sir Joseph Hooker calls attention to the fact that it was figured by Rumphius as early as 1690.

A portrait of *George Bentham*, accompanied by a biographical memoir by Sir Joseph Hooker, his collaborator on the great "Genera Plantarum," appears in the concluding number of Vol. XII of the *Annals of Botany*.

Professor Sargent contributes to the *Botanical Gazette* for February an article on new or little-known North American trees, in which the Thrinax-like palms of Florida are revised, — the new genus Coccothrinax being proposed, — and a new elm related to *Ulmus racemosa* is described under the name *U. serotina*.

Recent issues of the *Deutsche Botanische Monatsschrift* contain a series of articles, by W. N. Suksdorf, entitled "Washingtonische Pflanzen," and descriptive of a considerable number of species and varieties from our northwest coast, which are believed to be as yet undescribed or unnamed.

A notion of the extent to which scientific as well as military and commercial activity is penetrating Africa may be obtained from an examination of the issue of the *Botanische Jahrbücher* of January 31, the greater part of which is devoted to a continuation of the "Beiträge zur Flora von Afrika," by Dr. Engler and his associates.

Vanilla culture, as practiced in the Seychelles, is described by S. J. Galbraith in *Bulletin No. 21* of the United States Department of Agriculture, Division of Botany.

The acaulescent blue violets of the vicinity of Ottawa are described and figured by James M. Macoun in *The Ottawa Naturalist* for January.

Bulletin No. 48 of the Texas Agricultural Experiment Station, which is devoted to grapes, contains a half-tone reproduction of a photograph by Professor Munson, showing the seeds of North American grapes.

Plants yielding Myrrh and Bdellium are monographically treated in January numbers of the *Pharmaceutical Journal* by E. M. Holmes, of the Museum of the Pharmaceutical Society of Great Britain.

Robert Smith contributes a short article "on the study of plant associations" to *Natural Science* for February, illustrating his remarks

by an analysis of the flora of the Ayrshire coast between Prestwick and Troon.

"Catalogue of herbarium specimens for exchange," a rather unusual title for a bulletin of an agricultural experiment station, is the title of *Bulletin No. 51* of the North Carolina station, issued under date of December 16 last.

Silphium lanceolatum is the name proposed by Mr. Canby in the February number of the *Botanical Gazette* for a new species of the South Atlantic region.

The comparative morphology of cactus embryos and seedlings is considered by Professor Ganong in the *Annals of Botany* for December.

Professor Rowlee describes and figures two Mexican willows — one new — in the *Botanical Gazette* for February.

Meconopsis heterophylla, of California, is figured in the January number of the *Botanical Magazine*.

Stachys arvensis, in Australia, is said to cause fatal cases of poisoning when eaten by bullocks and horses. — *Queensland Agr. Journ.*, January.

Lewisia tweedyi, of Washington, is figured in the *Botanical Magazine* for January.

NEWS.

A RECENT fire in Geneva destroyed the herbarium of Professor Chodat, of the university.

A French Association des Anatomistes has recently been formed, holding its first meeting in Paris, January 5 and 6. The secretary is Professor A. Nicholas, of Nancy.

The United States Fish Commission will have $19,200 for scientific investigation during the present year.

The eighth session of the International Geological Congress will be held in Paris, August 16–28, 1900. Circulars regarding the proposed excursions will be issued this year.

The Gray herbarium, of Harvard University, has recently purchased the collection of Compositæ of the late Dr. F. W. Klatt, of Hamburg. It contains about 11,000 specimens, and will probably add 60 genera and 1500 species to the Gray herbarium. The Gray herbarium previously contained about 35,000 sheets of composites.

The following state legislation in 1898 is of interest to naturalists. New Jersey provides for a state entomologist; Louisiana has passed a bill providing for the establishment of a biological station in the Gulf of Mexico, to coöperate with the United States Fish Commission for the investigation of problems affecting the fisheries of the state; New York forbids the killing at any time of wild moose, elk, caribou, and antelope; Ohio has repealed the law relative to the trapping or killing of muskrats, mink, and otter.

The Saxon government is to erect a new museum building at Dresden, and the director of the museum, Dr. A. B. Meyer, with the architect, Professor Wallot, will visit the United States this autumn for the purpose of studying the museum buildings of this country.

For some years there has been a growing feeling in England that the northern coal fields will give out, and that endeavors should be made to find coal in other parts of the island. To ascertain whether other workable beds occurred in other regions, a boring has been made at Brabourne, in Kent, which has now reached a depth of 2000 feet, and is now in lower carboniferous rocks.

An English committee has been formed to conduct the study of the region around Lake Tanganyika, in Central Africa. It is hoped that they will be able to study especially the aquatic fauna and flora of the region, as well as its geology. An appeal is now made for funds to carry out the plans, it being estimated that about $25,000 will be needed for the purpose.

The *American Journal of Physiology* has adopted a plan, advocated for some years by Dr. Bowditch, of publishing with each number titles of the various articles on thin paper, which can be cut out and pasted on index cards. Each title is accompanied by a brief abstract of the matter recorded in the article.

At the annual election of the California Academy of Sciences, held January 3, the following officers were elected: President, William E. Ritter; 1st Vice-President, Charles H. Gilbert; 2d Vice-President, H. H. Behr; Corresponding Secretary, J. O'B. Gunn; Recording Secretary, G. P. Rixford; Treasurer, L. H. Foote; Librarian, Louis Falkenau; Director of the Museum, Charles A. Keeler; Trustees, William M. Pierson, William H. Crocker, James F. Houghton, C. E. Grunsky, George C. Perkins, George W. Dickie, E. J. Molera. The yearly report of the president, William E. Ritter, shows the past year to have been one of earnest activity in the various departments. The necessity is urged of concentrating both the efforts and the funds of the academy toward making complete the natural history collections of the state. Especial stress is laid upon the desirability of exploring the waters of the Pacific that wash the California coast. A gift of $1000 from C. P. Huntington for the publication fund was announced.

The Academy of Sciences of Vienna has sent an expedition to South Arabia under the leadership of Count Lundberg. Professor Oskar Simony accompanies the expedition as botanist and physicist; Dr. Cossmat, geologist; and Dr. Gimley, as physician and botanist.

Trinity College, at Hartford, Conn., is to have a Natural History Hall, erected at a cost of $40,000. The collections and laboratories are at present in cramped quarters in the basement of the main building of the college.

Dr. Ulric Dahlgren has been appointed as assistant director of the Marine Biological Laboratory at Woods Holl, as successor to the late Professor Peck.

Mr. J. G. Baker has resigned his position as director of the Kew Botanical Herbarium.

The British government has established a botanical garden and experiment station at Uganda, Central Africa, under the directorship of Alexander Whyte.

Dr. J. Gaule, professor of physiology in the University of Zürich, has resigned his position.

At a recent meeting of the Board of Management of the Marine Biological Laboratory of Canada it was resolved to proceed at once with the construction of a floating station, to be ready for occupation early in June, and for the coming summer it will be located at St. Andrews. The Board was enlarged by the addition of Dr. A. B. MacCallum, of Toronto University. The executive officers are Professor E. E. Prince, Director, and Professor D. P. Penhallow, Secretary-Treasurer.

The University of Cambridge has awarded the Walsingham medal to J. Graham Kerr for his paper on the life history of Lepidosiren.

Dr. O. Seydel, for some years lektor in anatomy in the University of Amsterdam, and well known for his researches on the organ of Jacobson, has resigned and has returned to Germany.

The litigation over the Nobel bequest has come to an end, and there is now about $7,000,000 available for prizes. There will be five of these to be awarded annually, with a value of about $40,000 each.

The University of Aberdeen has under consideration the formation of loan collections of natural history to be suitable for instruction in schools. These are to be loaned to teachers, who will use them in their classes and be responsible for their safe return. Similar collections would be of great value in certain regions of the United States, and if we remember aright the University of Illinois at one time had a similar plan under consideration, if not in actual operation.

Appointments: Dr. Angelo Andres, formerly professor of general and agricultural zoölogy in the higher agricultural school at Milan, has been called to the chair of zoölogy in the University of Parma. — R. T. Baker, curator of the Technological Museum at Sydney, New South Wales. — Elmer D. Ball, assistant entomologist in the Colorado Experiment Station. — Dr. F. J. Becker, of Prag, professor of mineralogy in the University of Vienna. — Dr. J. Behrens, bacteriologist at Berlin. — Dr. P. Berggren, professor of botany in the Uni-

versity of Lund, Sweden.—Dr. L. Böhmig, professor extraordinarius of zoölogy in the University of Graz.—Karl Brischke, director of the botanical garden at Thorn.— Dr. Capitan, professor of prehistoric anthropology at Paris.— Dr. Friedrich Dahl, assistant in the zoölogical museum in Berlin.—Dr. Dannenberg, of Aachen, professor of mineralogy and geology in the mining school at Clausthal, Germany. —Dr. Rudolf Disselhorst, professor of animal physiology in the University of Halle.—Dr. Max von Frey, professor of physiology in the University of Zürich.—Dr. Thaddeus von Garbowski, of Vienna, privat docent for zoölogy in the University of Cracow.— M. Gravier, assistant in the Mûseum of Natural History at Paris.— Dr. E. Hallier, of Munich, assistant in the Botanical Museum at Hamburg.— Dr. Hans Held, professor extraordinarius of anatomy in the University of Leipzig.— Mr. W. B. Hemsley, curator of the Kew Herbarium.— Dr. Hettner, of Tübingen, professor of geography in the University of Würzburg.— Dr. Casimir Kwietnewski, assistant in the museum of zoölogy and comparative anatomy of the University of Messina. —Alberto Löfgren, director of the botanical gardens at São Paulo, Brazil.— Professor D. T. MacDougal, of the University of Minnesota, director of the laboratories in the New York Botanical Garden. — Dr. A. Manrizio, assistant in botany in the Agricultural School in Berlin.—Dr. Ernst Mehnert, of Strassburg, privat docent for anatomy in the University of Halle.— A. S. Miller, geologist to the Idaho Experiment Station.— Dr. Alois Mrazek, privat docent for zoölogy in the Bohemian University at Prag.—Dr. Adolf Osterwalder, assistant in the vegetable physiological laboratory of the Agricultural Station at Wädensweil, Switzerland.—Dr. Pelikan, professor extraordinarius of mineralogy in the German University at Prag.—Dr. Hans Rebel, privat docent for zoölogy in the Vienna Agricultural School. — Dr. Bernard Schmid, privat docent for botany in the University of Tübingen. — Dr. L. S. Schultze, assistant in the zoölogical institute of the University of Jena.—Professor D'Arcy W. Thompson, of Dundee, member of the Fishery Board for Scotland.— Alexandro Trotter, assistant in the Padua Botanical Gardens.—Dr. Carl Freiherr von Tubeuf, director of the botanical laboratory in the Berlin Experiment Station.—Dr. Karl Wehmer, privat docent for mycology in the Hannover Technical School, titular professor.— Dr. Franz Werner, privat docent for zoölogy in the University of Vienna.—Dr. N. Wille, curator of the museum and herbarium of the University of Christiania. — Dr. A. Zalevski, privat docent for botany in the University of Lemberg.

Deaths: W. G. Atherstone, student of South African geology. — Charles E. Beddome, conchologist, at Hobartstown, Tasmania, September 1. — Dr. Sven Borgström, student of mosses, at Stockholm, May 13, 1898, aged 72. — Karl Fried. Wilh. Claus, professor of zoölogy at the University of Vienna, January 18, aged 63. — William Colchester, a collector of fossils, at Cambridge, England, in December, at an advanced age. — Achille Costa, professor of zoölogy in the University of Naples, in November. — Dr. Gottlieb Gluge, formerly professor of anatomy and physiology in the University of Brussels, aged 86. — Mr. Gilbert H. Hicks, first assistant botanist in the Department of Agriculture, Dec. 7, 1898. — Rev. Thomas Hincks, at Clifton, England, January 26. He was the author of valuable manuals of the British Hydroids and Polyzoa. — Professor Paul Kramer, the student of Acari, in Magdeburg, in November. — Dr. Hans C. Müller, ornithologist, at Thorshavn, Faroe Island, Dec. 24, 1897, aged 70. — Dr. Hermann Müller, privat docent for bacteriology in the University of Vienna, aged 32. — Dr. Karl Müller, the well-known bryologist of Halle, and editor of *Die Natur*, February 9, at the age of 80 years. — Paul Iérémèïew, professor at the Institute of Mines, St. Petersburg, and member of the Imperial Academy. — Wilbur Wilson Thoburn, professor of bio-mechanics in the Leland Stanford University. — Emerich Vellay, the Hungarian entomologist, August 6. — Dr. Constantin Vousakis, professor of physiology in the University of Athens. — Anton W. Wiebke, ornithologist, of Hamburg. — Dr. G. Wolffhügel, professor of hygiene in the University of Göttingen.

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(The regular exchanges of the *American Naturalist* are not included.)

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(*No. 388 was mailed March 8.*)